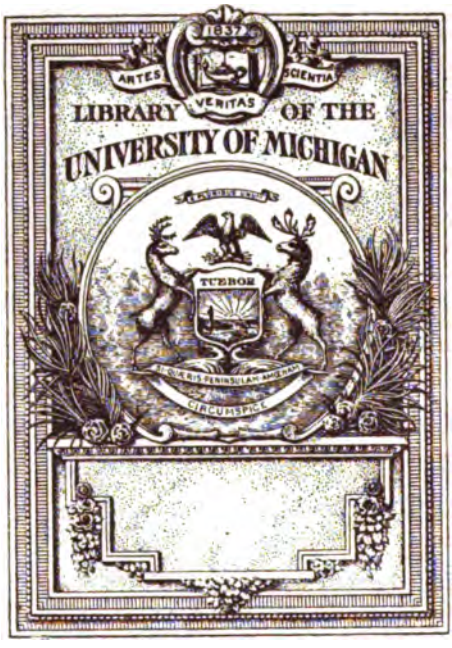

THE GEOLOGY OF WAYNE COUNTY, OHIO

DISSERTATION

PRESENTED IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR THE DEGREE OF DOCTOR OF PHILOSOPHY IN THE GRADUATE SCHOOL OF THE OHIO STATE UNIVERSITY

BY

GUY WOOLARD CONREY

The Ohio State University

1921

BIOGRAPHY

Guy Woolard Conrey was born in Northboro, Iowa, on December 10, 1887. He graduated from the Greenfield, Iowa, High School in 1904. He attended Simpson College, Indianola, Iowa, from 1904 to 1907. During 1905-06 and 1906-07 he was assistant in Chemistry. He entered the University of Michigan in the fall of 1907 and received the degree of A. B. in June, 1908. Following graduate study in Chemistry and Physics during the summer of 1908 and the year 1908-09, the degree of M. A. was granted in June, 1909. During the year 1908-09 he was assistant in Physical Chemistry under Dr. S. C. Lind. In September, 1909, he was appointed Chemist and Field Assistant in the Division of Soils, Wisconsin Geological and Natural History Survey. From 1911 to 1917 he was Chemist in charge of the Soil Survey Laboratory and Field Assistant. During 1914-15 he was Instructor in Soils, University of Wisconsin. Between 1909 and 1917 graduate study in Soils and Optical Mineralogy was pursued at irregular intervals. In April, 1917, he was appointed Instructor in Agricultural Chemistry and Soils, Ohio State University, and Assistant in Soil Surveying, Ohio Agricultural Experiment Station. In 1920, in addition to his duties as Instructor in Ohio State University, he was placed in charge of the Ohio Soil Survey.

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FOREWORD

The geological survey of Wayne County was undertaken at the suggestion of Dr. E. R. Allen, formerly of the Ohio Agricultural Experiment Station, Wooster, Ohio. Certain problems in soil classification necessitated additional information concerning the geology of the county. A cooperative agreement was arranged between Dr. J. A. Bownocker, State Geologist, Director Charles E. Thorne, Ohio Agricultural Experiment Station, and Dr. Firman E. Bear, Soils Department, Ohio State University, whereby the writer should spend the field season of 1919 in making a geological survey of this county.

The field work was under the general direction of Dr. J. A. Bownocker, who also directed the work on economic geology. Professor J. E. Hyde, Western Reserve University, directed the work on the stratigraphy of the Mississippian formations; Mr. Wilber Stout, Assistant Geologist, Geological Survey of Ohio, on the Pennsylvanian formations, and Professor T. M. Hills, formerly of the Geology Department, Ohio State University, on Pleistocene Geology. Professor J. E. Carman, Ohio State University, made many helpful suggestions concerning the latter phase of the work and also read the manuscript. In the identification of fossils much assistance was given by Miss Helen Morningstar, who identified the fossils in the Pottsville formation. The line marking the contact of the Pennsylvanian and Mississippian systems as shown on the Areal Map was kindly furnished the writer by Dr. J. A. Bownocker from data collected by Professor G. F. Lamb for the Geologic Map of Ohio. Dr. J. G. Black, formerly professor of geology, College of Wooster, offered many helpful suggestions during the progress of the work. To each of these the writer desires to acknowledge his indebtedness, and especially to Director Charles E. Thorne, whose kindness in releasing the writer from soil survey work during 1919 has made this bulletin possible.

INTRODUCTION

Wayne County is situated in northeastern Ohio about 36 miles south of Lake Erie and 58 miles west of the Pennsylvania state line. The county is rectangular in form, being 23 miles from north to south and 25 miles from east to west, with an area of about 557 square miles. It is subdivided into townships 6 miles square and each of these into thirty-six sections, 1 mile square. The county is bounded on the north by Medina and Summit counties; on the east by Stark and Summit; on the south by Holmes, and on the west by Ashland. It includes approximately the area between parallels 40° 40′ and 41° north, and meridians 81° 40′ and 82° 10′ west. The northern county line forms the south boundary of the Connecticut Western Reserve.

The area included within the county comprises parts of six 15-minute quadrangles of the United States Geological Survey—Massillon, Wooster, West Salem, Navarre, Millersburg, and Loudonville.[1]

[1]These maps may be procured from the United States Geological Survey for 10 cents per map.

PART I

PHYSIOGRAPHY

CHAPTER I

PHYSIOGRAPHIC RELATIONS

The State of Ohio falls within two of the chief physiographic divisions of the United States, the Central Lowlands and the Allegheny Plateau. The boundary between these divisions crosses the State from northeast to southwest and has been traced by Leverett[1] as follows: "It follows the lake border southwestward to the vicinity of Cleveland, Ohio, lying usually but 5 to 10 miles south of the lake, though at the Grand River Basin in northeastern Ohio it extends southward about 40 miles. A short distance west from Cleveland the hills bear away from Lake Erie to the vicinity of the continental divide in Medina, Ashland, and Richland counties. From near Mansfield in Richland County the border turns southward and maintains this course for nearly 100 miles, constituting the eastern rim of the Scioto Basin. It then swings westward across northern Ross County, passing a short distance north of the city of Chillicothe, and enters the northern part of Highland County. Here again it turns southward and passes through Highland and Adams counties into Kentucky, crossing the Ohio River near the mouth of Brush Creek, a few miles above Manchester, Ohio."

The boundary just traced passes west of Wayne County, which is therefore in the glaciated portion of the Allegheny Plateau.

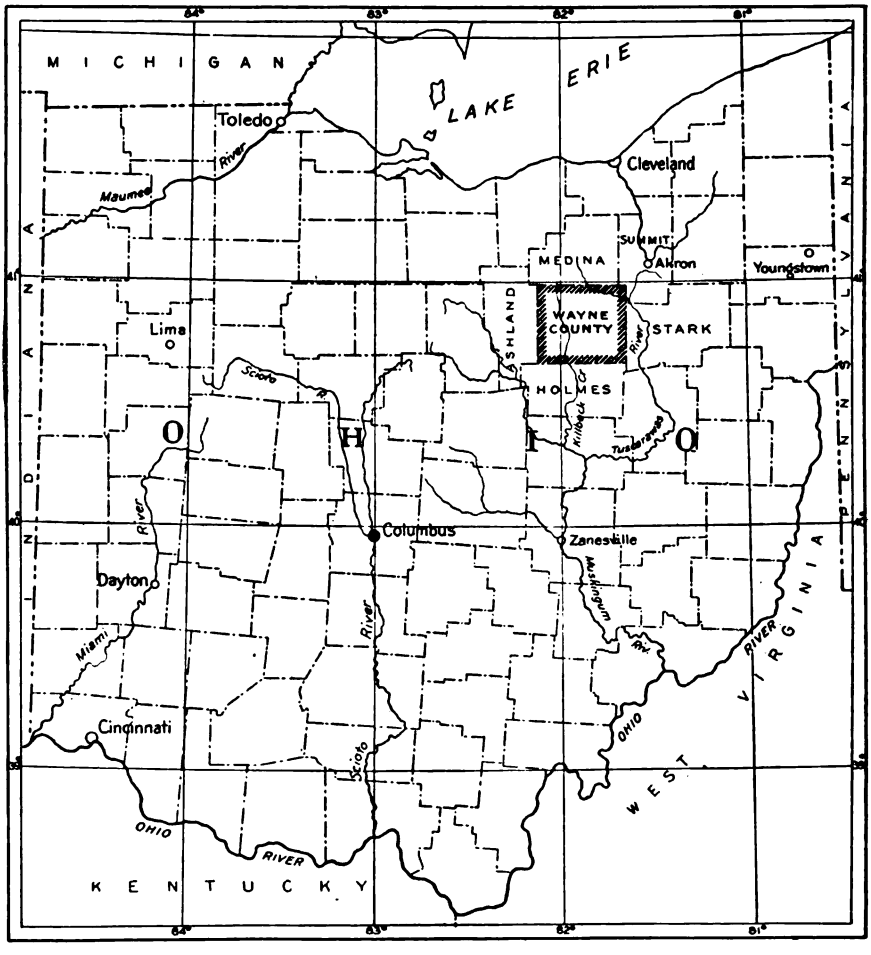
PRESENT DRAINAGE SYSTEM

Rivers

The divide, which separates the drainage of the Lake Erie basin from that of the Ohio River, crosses southern Medina, northern Ashland and Richland counties, passes to the north and west of Wayne County which is therefore within the drainage basin of the Ohio River. The chief drainage lines, which are three in number, lead to the south and southeast. Of these Killbuck Creek flows south across the west central part of the county, and Muddy Fork drains the western part.

[1]Leverett, Frank, Glaciation in the Erie and Ohio Basins, U. S. Geol. Surv., Mon. 41, 1902, p. 67.

The eastern part drains to the southeast into Chippewa, Newman, and Sugar creeks. All of the drainage eventually reaches the Muskingum River.



Map 1.—Index map

The extreme western edge of the county is drained by Muddy Fork, which loops into the county near West Salem and, after passing into Ashland County near Pleasant Home, re-enters Wayne County near Reedsburg. South of this place the waters of the stream originally spread out in a meandering course over the valley, but at present are led through a ditch to Blachleyville and from there west to the county line where it joins Jerome Fork. The southern part of this valley from Craigton north has no natural drainage except as the waters spread out over the valley and gradually move north to join Muddy Fork. After joining Jerome Fork a short distance west of the county line, the stream, known as Lake Fork, flows south to the Mohican River

and eventually into the Muskingum near Coshocton. The southwestern part of Clinton Township drains into Odell Lake which empties into Lake Fork.

Killbuck Creek and its tributaries drain a much larger area of the county than any other stream. It rises near Golden Corners in Canaan Township, and flows to the northeast, entering a large valley near Creston where it turns to the north and just south of the county line to the west. After passing Burbank it flows through a rock-floored channel at the base of the upland, till it enters the broad valley near Burbank Station where it turns to the south. From this place the original course was very meandering and in places it passed through peat and muck deposits but a ditch has straightened its course and carries the waters to the south past Wooster. In the lower part of its course in Franklin Township the waters spread out on the bottom and have formed a swamp. This results from the level surface and inadequate outlet to the south of the county. The waters of Killbuck Creek eventually empty into the Muskingum River. Salt Creek drains eastern Franklin and most of Salt Creek townships and flows southwest joining Killbuck Creek south of the county line. Apple Creek, rising a short distance north of Maysville in Salt Creek Township, flows to the northwest and joins the Killbuck at Wooster. Near Apple Creek village it flows in a shallow channel across a broad flat, but east of Wooster it has a valley with a depth of about 100 feet. With its tributaries it drains most of East Union and Wayne townships.

East of the divide which limits Killbuck basin all of the drainage eventually passes to the east and southeast to join the Tuscarawas River which flows into the Muskingum and this in turn into the Ohio River.

Orrville is situated on the divide between three creeks. The northern part of the city drains to the northeast into Little Chippewa Creek, the eastern part into Newman Creek, and the southwestern part into a tributary of Sugar Creek. In the flat between the headwaters of Little Chippewa and Newman creeks there is no noticeable natural divide. Ditches have been constructed in the swamp in which these streams have their sources and lead the waters in opposite directions. These streams are separated from Sugar Creek drainage to the south by a low morainic divide.

The most extensive drainage system in the eastern part of the county is that of Sugar Creek. It rises in the southern part of Canaan and Milton townships and flows to the southeast, draining parts of Wayne and most of Green townships. A few miles southeast of Smithville it enters a broad valley across which its course is through artificial ditches. South of Orrville it is joined from the south by Little Sugar Creek the source of which is about 2½ miles from the southern county line in Paint Township. Continuing diagonally

across Sugar Creek Township it leaves the county just north of the township line and, after flowing through a very narrow valley for a short distance, enters a wide valley near Brewster. Paint Township is drained in part to the east and in part to the south by tributaries of Sugar Creek.

Little Chippewa Creek, which rises near Orrville, drains to the northwest into Chippewa Creek, much of the way through drainage ditches, and furnishes an outlet for the waters of northeastern Green and southern Milton townships.

Chippewa Creek heads in Medina County north of Chippewa Lake and flows southeast past Sterling, Rittman, and Easton leaving Wayne County in the southeastern corner of Chippewa Township. The present course of the creek is largely artificial, and from the construction of many miles of drainage ditches, large tracts of the valley through which Chippewa Creek flows, which originally were wet and soggy, are now good agricultural land. With the exception of Little Chippewa all the tributaries of Chippewa Creek from the south are rather short and the area drained is comparatively small. To the north many streams which join Chippewa Creek have their sources in Medina County and drain a considerable area in addition to that within Wayne County.

Newman Creek and its tributaries drain most of Baughman and part of Sugar Creek townships. An old tamarack swamp east of Orrville is drained by the Orrville ditch into Newman Creek. Two main tributaries flow into this creek, one from the north and the other from the south. Newark Creek from the south is formed by two branches near Dalton, the one from the south being separated from a tributary of Sugar Creek by a few gravelly knolls.

Lakes

There are only a few small lakes in the county. Fox Lake, the largest, which is less than three eighths of a mile across, is located in a preglacial valley in the northeastern part of Baughman Township. It is oval in shape, has an area of about 40 acres, and is fed by a small stream and possibly by springs. The lake has no visible outlet, but its waters undoubtedly escape beneath the surface to a smaller lake about a quarter of a mile away, which in turn drains to the southeast into Fox Run.

Not far from Easton in the northeast part of Section 17, Chippewa Township, a small lake less than a quarter of a mile in diameter lies in a morainic basin. It is fed by springs, and since it has no visible outlet, its waters must escape through the gravels which surround it.

In the southwestern corner of the county, not far from Shreve, there are several small lakes, varying from 25 to 60 rods in diameter,

surrounded in part by morainic knolls. In Section 21, Clinton Township, there are two such lakes, the waters of which find their way into drainage ditches and eventually into Odell Lake just south of the county line.

TOPOGRAPHY

The topography of Wayne County is a rolling upland with broad flat-bottomed valleys. The county lies a few miles within the glacial boundary and the characteristic features of a dissected plateau, so well shown farther southeast, are here modified to a considerable extent by the presence of a mantle of glacial drift, which evens the surface and produces long slopes of moderate steepness. However, in the southern and southeastern portions the surface is rough and the same is true in the northeastern part in the vicinity of Doylestown, but here erosion has been retarded by the resistant character of the underlying rocks.

The upland in the remainder of the county has a gently rolling surface which gradually becomes smoother toward the north and west. However, adjacent to the main valleys there is commonly a belt of dissected topography.

Several broad valleys with steep walls cross the county, and are occupied by relatively small streams. Killbuck Creek, flowing south, occupies a broad valley south of Wooster, whereas to the north, up the stream, the valley gradually narrows as far as Overton, beyond which place it widens. To the west an even broader valley (Craigton) with a general north-south direction has no natural drainage over a large part of its course.

The valley of Chippewa Creek is nearly 3 miles wide where the stream enters the county near Creston. From there it extends in a southeasterly direction across Milton and Chippewa townships, and narrows to about 1 mile near Rittman, one-half mile at Easton, and three-fourths mile at the eastern county line. Somewhat similar valleys extend east and northwest from Orrville. Another extends from near Smithville southeast to the county line, the broadest portion of this valley being southwest of Orrville.

The character of the valley walls and also of the valley floors is quite variable. Steep rocky slopes give way at places within a few miles to long gentle slopes extending a mile or more to the upland. The valley floors are commonly level stretches underlain by alluvium, or by peat or muck, but at places there are level to undulating terraces and rough knolly areas.

The elevation of the surface of the county varies from 837 feet above sea level where Killbuck Creek leaves the county to slightly over 1,320 feet near Mt. Eaton, giving a total relief of almost 500 feet. The area with an elevation greater than 1,300 feet above sea level is

very limited, and includes a few hills in the vicinity of Mt. Eaton, Paint Township, and in the southern part of Salt Creek Township. The highest place in the county is either the hill just south of Mt. Eaton, or that in the central part of Section 13, Salt Creek Township. Both have an elevation of more than 1,320 feet above sea level. A hill one-half mile south of the county line in Holmes County to the south of Section 24, Salt Creek Township, has an elevation slightly greater than 1,360 feet, and is probably the highest elevation for this region. The greatest relief in the county is near Doylestown, where a hill rises over 300 feet in less than two miles, but the altitude of this is less than 1,300 feet.

By far the largest portion of the upland of the county lies between 1,100 and 1,200 feet above sea level, with only the highest places along the divides exceeding 1,200 feet. Although many of the divides in the central part of the county reach 1,180 feet, by far the largest part of the area lies between 1,140 and 1,160. Between Wooster and Chippewa Valley 1,200 feet is exceeded at a few places only, although a hill near Golden Corners reaches 1 260 feet, which is higher than any place in the county west of the Killbuck.

The elevation of the floors of the large valleys of the county is variable. Craigton Valley in the western part of the county has an elevation of 949 to 960 feet north of Craigton Village, whereas Killbuck Valley, 8 or 10 miles to the east, varies from 837 feet near the southern county line to 858 near Wooster, being about 100 feet lower than the valley to the west. Chippewa Valley, 1 mile west of the county line, lies 951 feet above sea level, while Newman Creek Valley east of Orrville is very close to 1,000 feet, and the valley near Dalton 1,060 to 1,080. Sugar Creek Valley is of about the same elevation as the valley east of Orrville.

PREGLACIAL DRAINAGE SYSTEM

An examination of the present drainage of the county shows many features which are not characteristic of normal valley development. This is illustrated in the course of Chippewa Creek which is in a valley nearly 3 miles wide where it enters the county and only three-fourths mile wide where it leaves the county. The course of Killbuck Creek in flowing to the north for several miles, then reversing and taking a southerly direction is also abnormal. Well records have revealed the presence of deeply buried channels. Similar conditions are to be found over a large part of Ohio, and also in adjoining states.

View across Killbuck Valley to the southwest from Ohio Agricultural Experiment Station

The work of Chamberlin,[1] Leverett,[1] Tight,[2] Bownocker,[3] Todd,[4] and others has shown that glaciation has produced marked changes in the drainage of the State, amounting almost to complete reversal in direction, and that the preglacial drainage was to the north and northwest, instead of to the south as at present.

J. H. Todd,[4] through a study of the preglacial drainage of Wayne County, has shown that before glacial times the drainage was to the north in the direction of Lake Erie instead of to the south as at present. The discussion which follows is based in part upon Todd's paper and in part on observations made during the present investigation. Unless indicated otherwise the quotations are from Todd's paper. The location of the preglacial drainage lines is shown on the drainage map of the county (Map II).

The preglacial drainage of the county apparently was to the north. The main stream of the region entered the county north of Big Prairie in the southwestern corner of the county, and flowed to the northeast past Shreve to Wooster in the old valley now followed by the Pennsylvania Railroad. From Wooster the stream led to Orrville, and then followed the old valley now occupied by Little Chippewa Creek until it reached the valley of Chippewa Creek where it took a northwesterly course, leaving the county north of Sterling. Tributary streams joined this main or trunk stream at various places. The probable disposition of the various channels is shown on the drainage map. The evidence, on which the reconstruction of the preglacial drainage of the county is based, follows:

In the western part of the county the valleys are those occupied by Muddy Fork near the county line and Killbuck Creek farther east. Well drilling in these valleys has shown that bed rock surface is more than 100 feet below the present streams. Killbuck Valley is followed south of Wooster by the Pennsylvania Railroad, but northeast of Shreve, the valley turns to the southeast, while the railroad continues on in a lowland passing Shreve and crossing the county line near Big Prairie. This lowland continues to the southwest as far as Loudonville where it turns to the northwest toward Mansfield. Todd gives the elevation of the rock floor of this lowland and of Killbuck Valley, and his elevations above Lake Erie are here calculated from sea level using 573 as the elevation of the lake.

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[1]Chamberlin, T. C., and Leverett, Frank, Further Studies of the Drainage Features of the Upper Ohio Basin, Amer. Jour. Sci., Vol. 47, 1894, pp. 248-283.

[2]Tight, W. G., Drainage Modifications in Southeastern Ohio and Adjacent Parts of West Virginia and Kentucky, U. S. Geol. Surv. P.P. No. 13, 1903.

[3]Bownocker, J. A., History of the Little Miami River, Ohio Acad. Sci., Special Papers, No. 3, 1900, pp. 32-45.

[4]Todd, J. H., Some Observations on the Preglacial Drainage of Wayne and Adjacent Counties, Ohio Acad. Sci., Special Papers, No. 3, 1900, pp. 46-67.

Elevations of the rock floor of the valley between Loudonville and Wooster

		Depth to rock Feet	Elevation of bed rock above sea level Feet
1.	Loudonville	150	835
2.	Lakes near Lake Fork	130	818
3.	Odell Lake	---	801
4.	Big Prairie	176	787
5.	Custaloga	170	783
6.	Shreve	60 to 105	773 (est.)
7.	1½ miles S. W. of Wooster	185	718

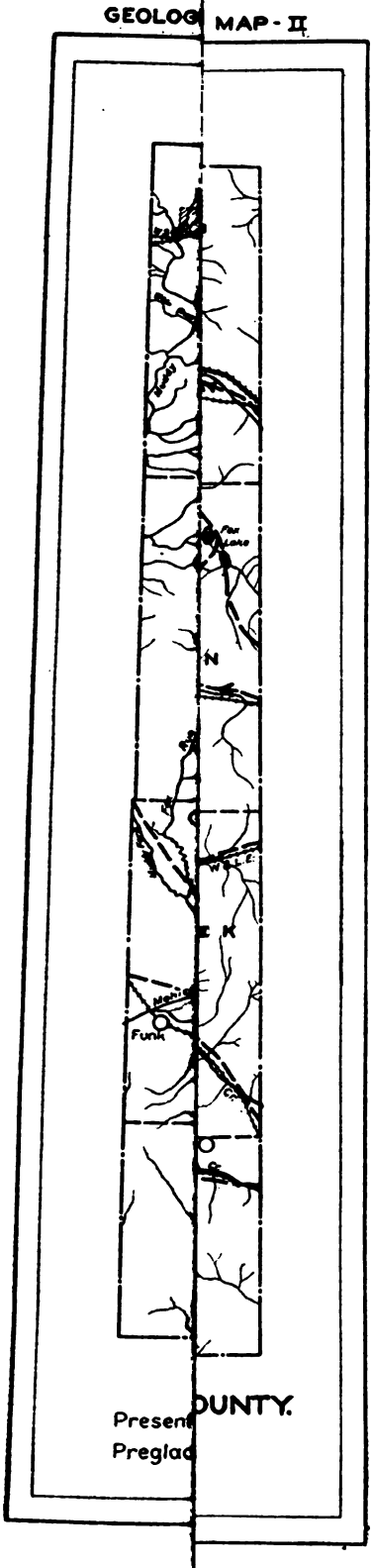
From these elevations it is evident that the floor of the preglacial valley slopes toward Wooster, and from its size and depth it seems very probable that this old valley carried the main stream of the region.

In the western part of the county Muddy Fork after crossing into Ashland County near Funk joins Jerome Fork to form Lake Fork. The latter flows to the south through a narrow valley, which is in marked contrast to the valleys of the two streams which have united to form it. Apparently there is a col in its valley less than 2 miles south of the village of Lake Fork.

The valleys of Muddy Fork and Jerome Fork, each a little more than a mile wide, unite near Funk to form a valley only slightly less than 2 miles in width which continues to the south for about 3 miles. The present surface of this valley is more than 100 feet above that of Killbuck, but the fill is reported to be greater. About 1 mile north of Craigton, rock lies at a depth of over 200 feet.

As to the outlet to this old valley there are two possibilities. One is to the south past Craigton and through the broad east-west preglacial valley in which Shreve and Big Prairie are located. In the valley southwest of Craigton is a large rock hill, located approximately in the center of the valley and rising over 100 feet above the present surface of the lowland. Two deep channels pass around this rock mass, one on the east nowhere more than one-half mile wide, and the other on the west which narrows down to about one-eighth mile. Both north and south of this rock hill the valley is about 2 miles wide. The channel west of the hill is rather narrow for the preglacial outlet, the one on the east hardly broad enough, but a possibility. Both connect near Custaloga with the valley leading toward Wooster.

A more probable outlet is south of Spring Valley past Millbrook. About a mile southwest of Spring Valley near the highway a well 140 feet deep did not reach rock, while 1 mile south no rock was encountered at a depth of 185 feet. One mile north of Millbrook rock was penetrated at 100 feet. This is probably on the north side of the channel. These records show that a valley has existed here which joins Killbuck to the east, and may have furnished an outlet for the waters from the west.


GEOLOG MAP - II
N
Funk
OUNTY.
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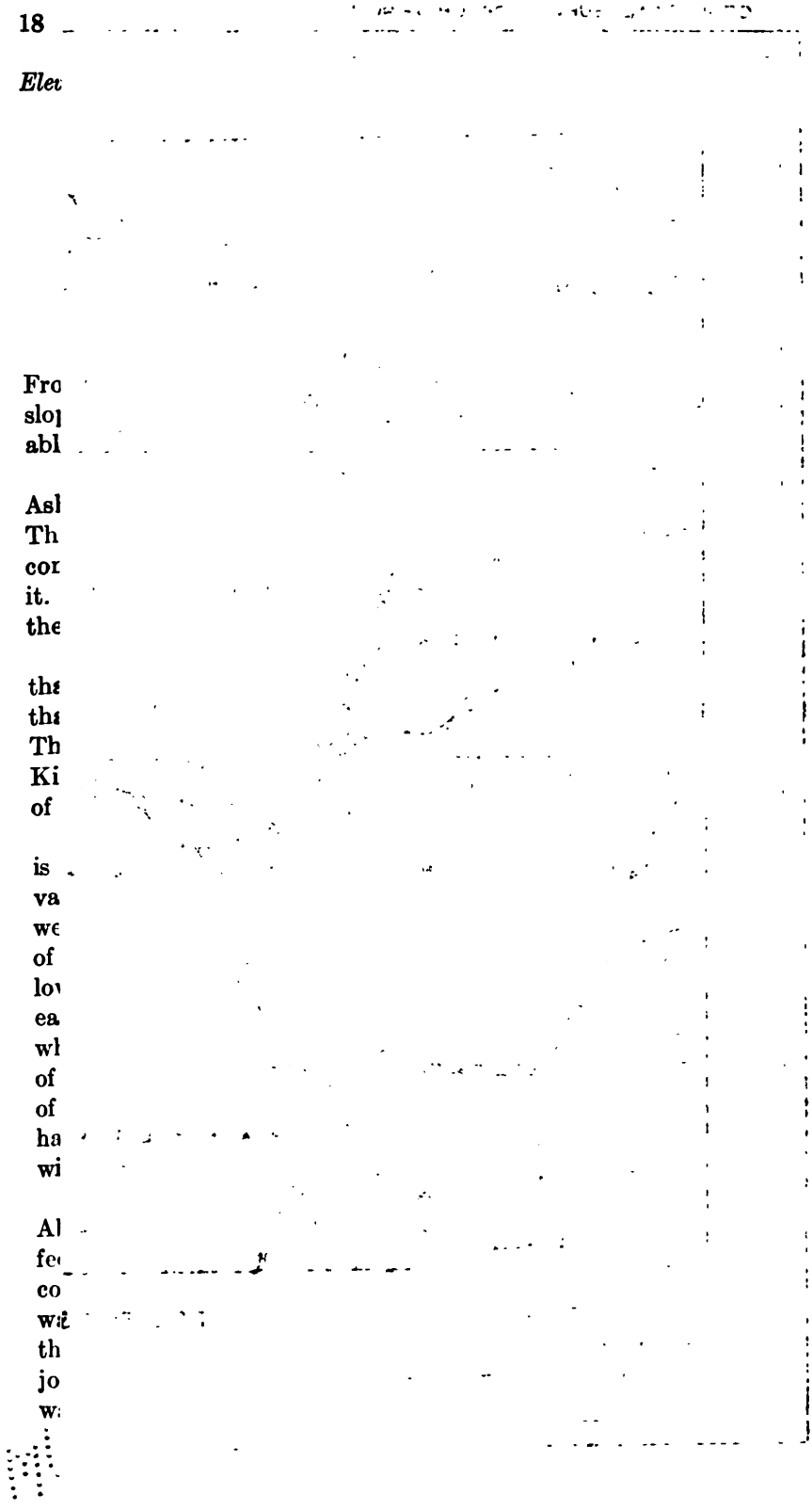


Before reaching Wooster two other tributary valleys enter this preglacial course, one from the south near Shreve, and the other from the southeast along the line which now carries the present drainage of the Killbuck to the south past Millersburg. It may be noted that the present Killbuck Valley narrows rapidly south of Kauke and Todd has located the col a few miles south of Millersburg, where the valley is narrowest and is in rock.

To the northwest of Wooster, Killbuck Valley narrows very rapidly, until a mile north of Overton it is less than a quarter of a mile wide, but farther north it broadens to almost a mile near the county line. It is evident that the large drainage channel southwest of Wooster did not continue north along this course, and it seems very probable that a divide was located a short distance north of the narrowest part of the valley which separated a north-flowing stream from one flowing to the south.

Little Killbuck Creek which joins the Killbuck about 3 miles northwest of Wooster flows in a channel which is cut partly in rock and partly in drift. Parts of the course apparently follow a preglacial valley much larger than the present one.

The location of the course of the large preglacial stream beyond Wooster is questionable. There is no surface continuation of it but Apple Creek, which flows from the southeast to join Killbuck near Wooster, occupies an old preglacial valley as is shown by a well record reported by Todd from the Mock farm in Section 2, East Union Township, where a depth of 185 feet (733 feet above sea level) was attained without striking rock. It is possible, therefore, that the old valley southwest of Wooster continued up Apple Creek Valley reversed as far as Section 2 at least.

From this place Todd considers that the channel passed to the northeast toward Orrville, 2½ miles southwest of which, in NE ¼ Section 2, East Union Township, rock was not reached at a depth of 110 feet (910 feet above sea level). In an attempt to locate this channel, every ravine on the east side of Apple Creek north of Apple Creek Village was examined and found to show rock outcrops except in Section 36, Wayne Township, where Spring Run has cut into a preglacial valley, but the existence of rock outcrops near by both to the north and south would seem to indicate a channel too narrow for the stream which has been traced past Wooster. It seems probable that the deep well reported by Todd in Section 7, East Union Township, and mentioned above, is in the north-south preglacial valley in which Apple Creek flows.

The evidence for a preglacial channel leading to the east through the upland from any point near Honeytown seems to be negative. But as Todd has said, "the preglacial water came here, and there is but one way for it to get out, and I must find that way under the high

gravel hills between here and Orrville." The possibility of a channel following Apple Creek Valley as far as the village of Apple Creek and then in a general way following the C. A. & C. Railroad past East Union to Orrville has suggested itself, although the data necessary to prove this could not be obtained. However, it seems very evident that there is a channel across this belt somewhere.

Assuming that the drainage from the channel near Wooster in some way reached Sugar Creek Valley southwest of Orrville, the farther course of the stream can be traced fairly easily. Near Orrville two tributaries joined the main stream, one from the northwest and the other from the southeast. The latter flowed through the old Sugar Creek Valley in a direction reverse to that of the present stream, and it seems probable that the main channel continued to the north past Orrville. At the city water works wells in the north part of town just west of the main highway leading to the north, rock was penetrated at 50 feet. The preglacial channel must have been a little to the west through Sections 24 and 25, Green Township. The present divide between Little Chippewa and Sugar creeks is a succession of low morainic knolls.

North of Orrville two valleys lead away, one to the east and the other to the northwest. To the east is the old tamarack swamp drained at present by Orrville Creek into Newman Creek. In the middle of the valley in Section 20, Baughman Township the depth to rock is greater than 132 feet; near the intersection of the railroad and highway in Section 23 it is 100 feet; while about one-fourth mile west of the county line it comes within 36 feet of the surface. Apparently the valley floor slopes to the west, so this valley in all probability did not furnish an outlet for the main drainage system, but rather it was the site of a tributary stream.

The probable outlet was to the north through the old valley now occupied by Little Chippewa Creek which joins that of Chippewa in the southern part of Milton Township.

That Chippewa Valley was the site of a preglacial channel of considerable depth is shown by the record of drilled wells. Near the crossroads in the south central part of Section 15, Milton Township, rock is reported at 171 feet, while one-half mile east it lies at 219 feet below the surface. A record given by Bownocker[1] for one of the salt wells near Rittman shows 173 feet to rock. A well in the south central part of Section 9, Milton Township, not far from Sterling, was put down to a depth of 185 feet without striking rock. All of these records are given for points along the sides of the valley and give no data as to the maximum depth. Todd reports that he had been informed of a well near Sterling which showed about 400 feet of drift, although he

[1]Bownocker, J. A., Geol. Surv. of Ohio, Fourth Series Bull. No. 8, 1906, p. 32.

was unable to determine its exact location. He points out that "such a channel in width and depth could not have been produced by drainage from the north, for it is only 12 miles to the rock crest above Medina city."

Todd maintains that all of the drainage from the eastern part of the Chippewa Valley passed Rittman and continued to the west and north after receiving the waters from the southwest through Little Chippewa Valley and also the headwaters of the present Killbuck south of Creston.

After leaving the county the drainage channel is thought to have continued to the north toward Chippewa Lake. Todd has presented evidence for an old channel extending from the Wayne County line east of Creston north past Chippewa Lake, and then to the northeast, passing south of Medina into Rocky River. Near Seville he reports 300 feet of drift; 1½ miles east of Leroy 149 feet; and 4½ miles south of Medina and northeast of Chippewa Lake 190 feet of drift without striking rock. "One-fourth mile north Waverly rock was struck at 125 feet, while 1½ miles south rock was struck in the Carboniferous Conglomerate at 42 feet." As the last well of the series, he reports one 3 miles due east of Medina near the head of Rocky River in which rock was not struck at a depth of 200 feet. The bottom of the well is reported to be 133 feet above Lake Erie, which would give an elevation for the rock floor of less than 706. This gives a channel whose floor is lower than that at Wooster and would provide an outlet for the drainage to the north through the preglacial Rocky River gorge.

Leverett[1] is "inclined to favor the view that this valley (Chippewa Valley) had a course eastward from Sterling to Warwick, and thence north past New Portage and Copley Marsh into the old Cuyahoga, that being a larger channel than old Rocky River Valley."

The shape of Chippewa Valley in Wayne County would seem to indicate a course to the northwest rather than to the east, as the valley is narrowest near the eastern county line. The depth to rock on the southern border of the valley near the molding sand plants in Section 25, Chippewa Township, is between 80 and 100 feet while two miles from the county line near the north border of the valley the record of an oil well showed 132 feet of drift. Apparently this part of the old valley must have almost vertical walls more than 100 feet high.

Near Easton a channel from the south, whose axis is approximately that of Red Run and Fox Lake, joins Chippewa Valley and widens to over a mile, only to narrow down again to less than a quarter of a mile at Easton.

As rock outcrops on the upland at Easton, also to the south a very short distance from the flood plain, it would seem to be too narrow

[1]Leverett, Frank, U. S. Geol. Surv., Mon. 41, 1902, p. 164.

a channel for the preglacial valley. It appears probable that the channel was about three-fourths of a mile north of the present stream where a great mass of drift extends above the flood plain. An old channel from the north joins the valley at this place.

Just west of Easton the valley broadens to about a mile in width, only to narrow down to about one-half mile south of Rittman. East of Rittman a tributary valley with about the same width as the Chippewa enters the county near New Prospect. The drift mass on which New Prospect is located narrows the present valley for about a mile, north of which it extends with much the same width as near Rittman into Medina County where it reaches the headwaters of Rocky River. There seems to be a possibility of this channel as an outlet for the drainage of that part of Chippewa Valley east of Rittman, but such a condition would necessitate a divide south of the village. Whether or not the drainage left the county through one or more than one channel can only be decided on further study of the region to the north in Medina and Summit counties.

Mention has been made of the fact that the upper part of Killbuck Valley, a short distance north of Overton, carried a stream flowing to the north in preglacial times. Todd maintains that this channel continued to the north through the Lodi marsh into old Black River. Drilling for gas in the northwestern part of the county has shown a depth of drift of over 100 feet at a number of places between West Salem and the Killbuck which indicates a tributary valley from the southwest.

A preglacial channel exists near Dalton in Sugar Creek Township which leads to the north and apparently joins Chippewa Valley near Easton after passing by way of Fox Lake Basin and Red Run. One mile south of Dalton a mine shaft penetrated drift to a depth of 100 feet. Other drill records show that the channel extended northward to the present Newman Creek Valley, north of which in Section 14, Baughman Township, the bed rock lies from 254 to 317 feet below the surface. This old channel may be a continuation of the one to the south of Newman Creek, and may extend to the north past Fox Lake and Red Run to Chippewa Valley.

CHAPTER II

GLACIAL DEPOSITS

The mantle rock of Wayne County includes glacial drift and stratified clay, sand, and gravel of Pleistocene age, and alluvium and organic deposits of Recent age. The glacial deposits consist of till of the Late Wisconsin stage and stratified deposits of glacial and interglacial stages. The postglacial deposits include alluvial fans, lacustrine silts and clays, accumulations of muck and peat, and flood-plain deposits.

During the Pleistocene or Glacial period the northwestern two-thirds of Ohio including Wayne County was glaciated. The line marking the limit has a southwestward course across Columbiana, Stark, and Holmes counties, thence southwest past Chillicothe to the Ohio River south of Brown County.

The Glacial period consisted of a series of ice invasions separated by long interglacial intervals. Deposits of the following glacial stages have been differentiated in central and eastern North America, the youngest being at the top:

6. Late Wisconsin stage.
5. Early Wisconsin stage.
4. Iowan stage.
3. Illinoian stage.
2. Kansan stage.
1. Sub-Aftonian or Jerseyan stage.

Leverett has recognized deposits of three glacial stages in Ohio:[1] the Illinoian, the Early Wisconsin, and the Late Wisconsin. The drift of the Late Wisconsin stage being the youngest, forms the surface deposits over a large proportion of the glacial area of the State. During this stage the ice margin was characterized by great lobes, following in general the direction of the larger drainage basins. Leverett differentiated three principal lobes in Ohio—the Miami lobe which occupied the Miami Valley in western Ohio, the Scioto lobe which occupied the Scioto Valley in central Ohio, and the Grand River lobe in northeastern Ohio. Between the last two there is a glaciated area on the headwaters of the Muskingum River designated by Leverett as the shoulder of the Scioto lobe. It is in this area that Wayne County is situated.

Probable Conditions Preceding Glaciation

In order to understand the effects of glaciation in the county the probable conditions in the region prior to glaciation must be consid-

[1]Leverett, Frank, U. S. Geol. Surv., Mon. 41, 1902, pp. 51-52.

ered. Following the deposition of the Pennsylvanian strata the surface of Wayne County with the surrounding region was uplifted and subjected to erosion for a very long time. There is no record in the county or the state of the events during much of the Mesozoic era and the Tertiary period, but these can be inferred from what is known to have happened in parts of eastern United States. Undoubtedly the region passed through one or more cycles of erosion during each of which its surface was more or less completely reduced to a peneplain, each cycle being followed by an uplift of the surface resulting in a rejuvenation of the streams and a renewal of erosion.[1]

The conditions immediately prior to the ice invasion can be inferred from a study of the bed rock topography of the county and a comparison with the topography of the unglaciated region to the south. Such a study reveals that the preglacial surface had a greater relief than the present one. The rock floors of the preglacial valleys in many instances are over 100 feet below their present streams, and were apparently bounded by steep valley walls. Through these deep gorge-like valleys the drainage waters flowed northward into the present Lake Erie Basin.

First Effects of the Advance of the Ice

As the ice advanced southward it dammed the northward-flowing streams, resulting in the development of temporary lakes in the valleys. These lakes rose to the level of some col and then established an outlet to the south. The advancing ice sheet made the life of these small lakes a brief one.

EVIDENCE FOR PRE-WISCONSIN GLACIAL STAGES

There is no conclusive evidence that Wayne County was covered by any of the pre-Wisconsin ice sheets. The eastern boundary of the Illinoian drift sheet to which the drift of southwestern Ohio belongs has been traced northward through Perry, Licking, and Coshocton, to a place near Nashville, Holmes County, where it passes beneath the Late Wisconsin drift sheet. The course of this boundary is such as to indicate that it extended across the western part of Wayne County.

At a number of places in this county there is a hard, compact, bluish, pebbly till, overlain by stratified deposits, and these in turn by a yellow, clayey till which may represent two ice invasions. Such an exposure in a bank of Killbuck Creek in the south-central part of Section 10, Canaan Township, gave the following record:

[1]Hubbard, G. D., et al, Columbus Folio, U. S. Geol. Surv., Folio No. 197, 1915, p. 11.

		Feet	Inches
6.	Yellow clayey till, containing comparatively few pebbles	20	--
5.	Rudely stratified sand and gravel	10	--
4.	Yellow sand, free from pebbles	1	--
3.	Gray-blue, laminated clay, free from pebbles	5	--
2.	Yellow sand containing a few small pebbles	--	3
1.	Hard, compact, blue clayey till, containing pebbles	15	--

Similar exposures were studied at a number of places in the county. There is no leached or oxidized zone at the top of the lower till at any of these exposures and both tills may belong to the same ice invasion, the intervening beds being accounted for by a minor retreat and advance of the ice. Further study over northeastern Ohio as a whole will be necessary before a definite conclusion as to the existence or nonexistence of a pre-Wisconsin drift sheet can be reached.

THE LATE WISCONSIN GLACIAL STAGE

The Late Wisconsin ice completely covered Wayne County and had its extreme limit from 2 to 12 miles south of the Wayne-Holmes county line. At its farthest advance a terminal moraine was built, following which, during the withdrawal of the ice from the region, recessional moraines were formed wherever the ice front rested for sufficient time to permit the accumulation of a marked thickness of drift. In Wayne County there are three principal recessional moraines. The remainder of the county is covered with a rather thin veneer of drift—the till sheet or ground moraine. Associated with the till deposits are the various forms of stratified drift which were laid down by the action of waters flowing from the melting ice; these include kames, eskers, valley trains, and lacustrine deposits.

The Direction of Movement of the Ice

Glacial striæ were observed at a number of places in the county and are listed below. Those previously published are so designated.[1]

	Bearing
Sect. 4, Milton Township	S. 32° E.
Doylestown, ½ mile south of	S. 40° E.
Doylestown (Whittlesey)	S. 36° E.
Doylestown (Leverett)	S. 40° E.
Doylestown (Leverett)	S. 32° E. to S. 50° E.
Sect. 11, East Union Township	S. 27° E.
Mount Eaton (Wooster)	S. 40° E. to S. 45° E.

From the above it is seen that the direction in the eastern part of

[1]Leverett, Frank, U. S. Geol. Surv., Mon. 41, 1902, p. 423.

the county is southeast. In the central and western parts of the county no striæ were observed. Leverett reports an observation near Holmesville in Holmes County, where the direction was S. 8° W.

Terminal and Recessional Moraines

The main morainic system.—The inner part of the main morainic system of the Late Wisconsin ice sheet crosses the southern part of Wayne County. Leverett[1] described this morainic system in Wayne and Ashland counties as "a tract 8 to 14 miles wide, the greatest width being in the vicinity of Killbuck Creek, where it is separated into three somewhat distinct belts with intervening tracts 2 miles or more in width, in which morainic features are rare." The two northernmost belts enter Wayne County from the east, whereas the outer southern belt at the glacial border crosses Holmes County to the south. Concerning these belts Leverett says, "it should not be understood that the belts have a clearly defined line of separation; there is simply a comparative scarcity of drift knolls in the portions indicated as non-morainic."

The outer morainic belt enters the northeastern part of Holmes County near Wilmot, and extends to the west past Millersburg and Nashville, 1, 8, and 5 miles, respectively, south of the Wayne County line. Concerning the portion of this outer belt west of Millersburg Leverett[2] says, "there are near the southern border of the drift, large dome-shaped hills, 50 to 100 feet in height, covering 20 to 40 acres or more each, which probably contain in every case a nucleus of sandstone, but whose outline is markedly in contrast with that of the unglaciated hills near them on the south. . . . . The drift knolls in this district are 10 to 20 feet high. They present fresh contours out to the very borders of the glaciated district. No indication of an attenuated sheet of drift was noted south of this outer member."

In southern Wayne County drift accumulations of a morainic character extend across the southern townships in a discontinuous belt, being well developed in the valleys and of minor importance on the uplands. (See glacial map of the county.) If these areas are connected across the intervening uplands they will correspond to the middle and inner or northern belts described by Leverett. The distribution of morainic accumulations in this region near the glacial border apparently has been determined to no small extent by the large preglacial valleys which are at places filled with drift knolls and ridges, while the uplands near by show comparatively few morainic features. Especially is this true of the east-west valleys, that is, in those at right angles to the direction of movement of the ice.

[1]Leverett, Frank, U. S. Geol. Surv., Mon. 41, 1902, p. 383.
[2]Idem., p. 391.

The most marked development of morainic features in the southern part of the county is in the preglacial valley west of Shreve where there is a notable accumulation of drift, although there are very few morainic features on the upland to the north. This belt, which Leverett includes in the middle member,[1] enters the county from the southwest a short distance east of Big Prairie and literally fills the old preglacial valley as far east as Killbuck Creek. The surface is made up of a succession of knolls and depressions; the knolls which vary in height from 10 to 40 feet commonly consist of gravelly material, and show in places considerable assortment, suggesting kame structures. Between the drift knolls and ridges are basins in many of which peat and muck have accumulated.

The width of this morainic tract varies from 1 mile near Shreve to 2 miles north of Big Prairie where the east-west valley opens to the north to join the great valley north of Craigton. The southern end of the rock hill in the valley near this village is the northern boundary of the morainic tract.

East of Shreve the moraine extends to the northeast into Killbuck Valley and morainic features occur on the upland to an elevation slightly more than 940 feet above sea level; a few such features occur also on the more elevated portions to the southeast. The little pond near the center of Section 24, Clinton Township, occupies a small depression of glacial origin.

On the upland north of the preglacial valley the drift for the most part is of slight thickness, rock outcrops are common, and the topography shows a regularity which is in marked contrast to the morainic surface of the valley.

A second morainic belt is located about 3½ miles north of Shreve, and extends from Killbuck Valley west past Millbrook and Spring Valley to the border of the preglacial valley north of Craigton. Leverett[1] designates this belt as part of the third or inner member. It occupies the site of a preglacial valley which has been filled with drift almost to the level of the upland. A depth to rock of more than 185 feet is shown at one place about 1½ miles west of Millbrook. The morainic knolls are seldom more than 10 or 15 feet in height, and over part of the belt, stream erosion has modified the surface so as to make the morainic features rather indefinite. West of Craigton Valley the continuation of the moraine is marked by a few glacial knolls in Section 36, Plain Township.

On the marshy bottom of the preglacial valley there are a number of "islands" which are in line with the morainic belt, and may be morainic knolls almost submerged in the swamp. These are covered with very fine sand of lacustrine origin.

The two separate morainic belts which exist to the west of Kill-

[1]Leverett, Frank, U. S. Geol. Surv., Mon. 41, 1902, p. 391.

buck Valley do not continue as distinct belts east of the valley. The moraine will therefore be treated as a single unit throughout the remainder of its extension across the county.

On the east side of Killbuck Creek morainic deposits occur along the valley wall, but at no place within the county do morainic knolls fill the valley. The flood plain of Killbuck is nowhere less than one-half mile in width, although it narrows down considerably only a short distance south of the county line.

On the upland east of Killbuck Valley in the vicinity of Moorland morainic features are lacking for several miles. Over an extended area the surface, though rolling, has a regular contour, the drift is thin, and rock outcrops are numerous. In the SW. ¼ of Section 6, Franklin Township, the ridge top is covered with a deposit of fine sand intermixed with clay extending to a depth of 3 or 4 feet. Only a short distance on either side, the till contains considerable gravel. This fine sand may be wind blown, the terrace to the west furnishing a possible source.

Heavy drift deposits exist in the valleys. Southeast of Moorland, Savage River flows through Big Hollow in a broad drift valley, is forced to the west by a morainic fill and has cut a channel in rock for about three quarters of a mile. The drift fill which has blocked the valley is very gravelly, and the surface is a succession of knolls and depressions. Probably nowhere in the county is the knoll and kettle topography better developed.

Along North Branch of Salt Creek morainic features are developed not only in the valley, but they also extend to the west over the upland for several miles. The morainic area extends northward along the valley from Fredericksburg for 3 or 4 miles and has a width of 1 to 3 miles. On the upland west of the valley, knolls composed of gravel and sand or clayey gravel are scattered over the morainic area, but these at few places exceed 20 or 30 feet in height. Toward the border of the area the morainic character becomes less pronounced and in places the boundary is rather indefinite.

The moraine in Section 17, Salt Creek Township, completely fills the valley through which Salt Creek formerly flowed and has forced the stream to cut an outlet through rock to the south. When the ice withdrew leaving this morainic dam a lake must have existed in the present Salt Creek Valley in sections 17, 20, and 21, Salt Creek Township, for in the NW. ¼ Section 20, a cut shows about 20 feet of laminated fine sand overlain by 40 feet of gravelly till. At the level of the present stream fine sand beds are tilted about 15°, dipping toward the northwest. About 100 feet to the south a tough blue pebbly till appears beneath the sand, in which several much weathered igneous bowlders occur. The blue till must have been deposited during an advance of the ice prior to the time of formation of the glacial dam.

A second and older morainic dam occurs farther up Salt Creek Valley in Section 22 near the county line; in the southern half a morainic ridge about 40 feet high crosses the valley and has diverted the stream, which flows through a rock channel at the base of the upland near the western end of the ridge. Just north of the ridge there is a gently morainic area with gravel knolls 5 to 10 feet high which a ditch shows to consist of roughly stratified sand and gravel; whereas the depressions between the knolls consist of a slightly gravelly clay which in places is practically gravel free. South of the main morainic ridge a level area, which appears to be outwash, extends for a short distance.

On the upland east of North Branch the moraine is lacking for several miles. At a number of places bowlders are strewn over the surface in considerable number, and a few low knolls rise above the general level.

Near Maysville the morainic features become more pronounced so that it is possible to indicate on the map an area, which includes the headwaters of Apple Creek and Little Sugar Creek, in which there is a decided morainic topography. South of Maysville the Moraine fills an old valley in the eastern part of Section 14, Salt Creek Township, and has diverted a formerly northward-flowing stream to the west through a rocky gorge. A north branch of this gorge receives the drainage from the southern end of the flat near Maysville, which is also the head of Apple Creek. The two streams are separated by a few low morainic knolls.

From Maysville the morainic belt can be traced eastward into Paint Township for about 1½ miles, beyond which the characteristic features are not well developed until Sugar Creek Valley is reached, where beginning in Section 22, Sugar Creek Township, and extending down the valley beyond the county line, there is a heavy accumulation of morainic deposits. Here the moraine nowhere extends onto the upland.

Sugar Creek Valley is nearly closed by the moraine in Section 22, Sugar Creek Township. On the upland near the highway just south of the stream the drift has a thickness of 45 feet, whereas one-half mile south rock was not encountered at a depth of 140 feet. Near the center of Section 23 the surface is covered with knolls and depressions, having a very morainic aspect, but north of the highway in this section, the morainic features are less pronounced. Farther down the valley in Section 36, morainic topography is well developed, the knolls varying from 25 to 35 feet in height, and some of the depressions containing small lakes.

Associated with the moraine are water-laid deposits, which are difficult to distinguish from those ice-laid, except where cuts expose the underlying material. Such is the case along the Wheeling and Lake Erie Railroad in SW. ¼ Section 25, Sugar Creek Township, where 25 feet of laminated clay and very fine sand are exposed in a cut. A

few gravelly layers occur throughout the exposure. Erosion has rounded the surface so as to make it appear like a morainic tract, rather than a water deposit.

In marked contrast to the morainic surface and the thick drift in the valley is the erosion surface and the thin covering of drift on the upland. Rock outcrops are common on the slopes and on the ridge tops. Since the ice was thicker in the valleys than on the upland, the result was a greater accumulation of drift in the valleys.

The Wabash Moraine.—This moraine includes a rather narrow belt with pronounced morainic features which crosses Congress and Canaan townships in the northwestern part of the county and marks the only major halt in the county of the ice during its withdrawal from the region, following the formation of the main morainic system. It forms an almost continuous belt across the county, being lacking only for a short distance in Killbuck Valley where erosion has removed all trace.

This morainic belt in northwestern Wayne County has been traced by Leverett from the interlobate moraine in Summit County westward across Ohio and into Indiana where it determines the direction of flow of the upper part of the Wabash River.[1]

The Wabash Moraine enters Wayne County a short distance west of Pleasant Home and crosses Congress Township in an easterly direction. Near the county line, where Muddy Fork has cut through the moraine, there is a very thick accumulation of drift, which consists of bowlder clay showing in places considerable assortment. The surface is quite rough due in part to glacial deposition and in part to erosion.

From a place one-half mile east of the county line in Section 25, Congress Township, the surface is comparatively even for about 1½ miles being broken only by a few knolls 10 or 15 feet high. An outwash plain borders the moraine on the south in this part of its course, being the only alluvial deposit associated with this moraine throughout the county. Near the southwest corner of Section 20 the moraine rises to an elevation of about 100 feet above any knoll to the west in the county and continues eastward for some distance as an elevated tract about a mile wide. Its surface is featured by many knolls and depressions giving local relief of 10 to 25 feet. North of Congress Village it becomes more irregular, with numerous gravelly knolls, but to the east as Killbuck Valley is approached, the morainic features become less pronounced.

The southern border of the morainic tract in Congress Township presents a rather regular front except in Section 28 where a narrow, slightly elevated tract extends into the southwestern part of the section beyond the main morainic front. The surface material of this elevated tract is sandy and differs from the lower lying ground a short

[1]Leverett, Frank, U. S. Geol. Surv., Mon. 41, 1902, pp. 545-566.

distance to the south where the till is of a clayey nature.

The ridge north of Shade Creek in Section 26 does not show marked surface irregularities, but is included in the moraine because of the large number of bowlders on the surface.

There is no evidence of the Wabash Moraine within Killbuck Valley, although it comes directly to the top of the west bluff which is quite steep and only thinly covered with drift. The moraine reappears on the east slope where bowlder clay extends well down the valley wall. The east valley wall, which for a number of miles to the south is quite steep, has a rather gentle slope in Section 24 where the moraine crosses, and is in marked contrast to the steep slope on the west side of the valley.

East of Killbuck Valley the moraine bears northeast across Canaan Township, where throughout much of its course it is a rather narrow elevated belt with characteristic knolls and depressions, the local relief of which is seldom more than 10 or 15 feet. A short distance south of the county line in sections 3 and 4, Canaan Township, the morainic belt widens and the surface becomes more irregular. In the northern part of these sections, kames 25 to 35 feet in height are numerous. The moraine leaves the county between Creston and Burbank. In Medina County the Wabash Moraine swings to the northeast and throughout the remainder of its course eastward it is very closely associated with the next or Ft. Wayne Moraine.

The St. Mary's or Ft. Wayne Moraine.—The next morainic belt north of the Wabash lies just north of the county line in Medina County and has its southern boundary in Wayne County at a few places. It was designated by Leverett the St. Mary's or Ft. Wayne Moraine.[1] From the interlobate tract in Summit County this moraine and the Wabash extend westward in close association as far as Seville, 2 miles north of Creston in Wayne County, where they divide and continue westward as independent moraines separated by 4 to 10 miles.

North of West Salem the southern border of the Ft. Wayne Moraine crosses into Wayne County for less than a quarter of a mile in sections 5 and 6, and also in the section in the extreme northwestern corner of the county. These areas contain a few low knolls about 10 or 15 feet in height, but northward in Medina County this east-west morainic belt has a stronger expression than the Wabash Moraine.

West of Burbank Station the Ft. Wayne Moraine extends into Killbuck Valley, fills it for one-half mile with a heavy accumulation of drift, and effectively diverts the drainage to the south. The topography of this area is slightly billowy, due to numerous low rounded knolls and shallow depressions. Near the southern end of the area a long narrow ridge has the appearance of an esker.

Two other small eskers were recognized in the county, and al-

[1]Leverett, Frank, U. S. Geol. Surv., Mon. 41, 1902, p. 566.

though not associated with the Ft. Wayne Moraine will be described at this place. One of these is located less than a mile west of Wooster in Section 5, Wooster Township, and has the form of a narrow ridge, extending northwest-southeast for about three-fourths of a mile. The crest of the ridge is a succession of rounded knolls which coalesce with one another. The eastern end of the ridge is composed largely of sand, but exposures farther west show stratified sand and gravel. For such ridges made up of a succession of kames the term kame-esker has been used and this ridge is of this type. The other esker is in Section 2, Salt Creek Township, in the valley of Apple Creek. It is a narrow ridge about one-fourth mile long, rises about 30 feet above the adjacent lowland, and consists of roughly stratified sand and gravel with cobbles 3 or 4 inches in diameter.

East of Burbank the Ft. Wayne Moraine nowhere touches the Wayne County line, but it continues eastward only a short distance north in Medina County where it joins the Wabash Moraine near Seville.

The Ground Moraine

Over a large proportion of the surface of Wayne County there is only a thin veneer of till, commonly spoken of as "bowlder clay." On the upland the thickness probably does not average more than 20 feet, whereas in valleys it becomes much greater. The till is entirely absent on some of the steep rocky slopes and narrow ridge tops.

The ground moraine is made up of drift which was transported beneath or within the ice and which was dropped as the ice melted. The absence of marked morainic accumulations over a large part of the county indicates that the ice in its retreat made no prolonged halts after the inner member of the main morainic system was formed until the position of the Wabash Moraine was reached.

The topography of the ground moraine is variable. In the southern part of the county the surface varies from rolling to rugged. To the north the topography is less hilly and, except in the vicinity of the main valleys, the upland is gently rolling, at places being so nearly level as to be imperfectly drained. The northeastern portion of the county north of Chippewa Valley is much more rolling than the western townships.

The ground moraine consists of yellow clay or sandy clay and silt containing numerous subangular to rounded rock fragments varying in size from pebbles to bowlders 3 feet or more in diameter. The small rock fragments are largely sandstone derived from the bed rock of this region, whereas the bowlders include various kinds of igneous and metamorphic rocks which have been carried into the State. The fine material in the till is largely of local derivation and its character is determined by the nature of the bed rocks in the various parts of the

county. Over the central and western portions the fine-grained Waverly sandstones, which weather to a coarse silt and very fine sand, have given a silty till. In the northern part of the county where shale forms the surface strata, the drift is composed largely of clay. The presence of the "Coal Measures" strata in the eastern part of the county with its alternating coarse sandstone and shale has resulted in a variability of the till not found in the western part. A slightly sandy clay is common, though the amount of sand in the till varies from place to place. In Chippewa Township in the northeastern part of the county there is an increase in the number of quartz pebbles in the till, probably derived from the Sharon conglomerate.

The thickness of the till on the uplands varies from place to place, but for the most part ranges from 10 to 25 feet. On the gently rolling portions of the upland, bed rock is commonly exposed in road cuts, though in the central and northern parts of the county there are areas of several square miles in which the bed rock is nowhere exposed along the highways, and where the drift is more than 10 to 15 feet thick. In places wells have penetrated 50 to 100 feet or more of drift. These places are located over preglacial valleys which have been so completely filled as to obliterate all surface evidence of their presence.

The greatest thickness of drift outside of the recessional moraine belts is to be found in the preglacial valleys. In these both assorted and unassorted drift is found, and some cuts show as many as six zones of stratified sand and gravel separated by till. Commonly the stratified zones do not persist laterally for any great distance, indicating that they were probably formed beneath or within the ice as lenses, rather than as outwash in front of the ice sheet.

The relation of a preglacial filled valley to a creek which now flows on it is illustrated by Apple Creek Valley. Near the village of Apple Creek the stream flows in a broad depression with its flood plain only a few feet below the level of the broad flat. Continuing down the valley the stream descends rapidly, cutting into the filled valley floor which is represented by shoulders well above the present stream level. The valley east of Wooster is bordered by a succession of these level-topped shoulders, the surfaces of which are at practically the same level as the broad flat west of Apple Creek. Between these shoulders and the flood plain are a number of benches of variable altitude, which have the appearance of terraces, but are of till, and are probably of lateral planation rather than constructional. The present valley of Apple Creek has been cut along the course of a filled valley since the ice receded. Numerous cuts furnish excellent exposures of the drift. In the NE. ¼ NE. ¼ Section 12, Wooster Township, there is an excellent exposure a short distance south of the Lincoln Highway near the west end of which are the following zones:

		Feet
3.	Yellowish brown, gravelly till	10
2.	Stratified sand containing a small amount of gravel	7
1.	Yellowish blue till	8

Thirty feet east of this place the sand (No. 2) was lacking, showing that it probably is a pocket in the till.

Four zones of gravel separated by till are exposed in a road cut one-half mile west of Honeytown in Section 12, Wooster Township. These zones show lateral variation, sand giving way to coarse gravel within 5 feet. These and other exposures indicate that there must have been considerable water action associated with the deposition of the drift in Apple Creek Valley. The level surface of the "shoulders" suggests gravel terraces, but the association of unstratified drift with lens-like bodies of water-laid deposits seems to indicate that the valley fill is largely ice-laid.

Minor Morainic Areas on the Ground Moraine

Numerous small isolated areas with marked morainic topography exist between the main morainic system and the Wabash Moraine, especially in the preglacial valleys, although some of them extend into the adjacent upland where, however, they are so feebly developed as to make their separation from the ground moraine uncertain and unsatisfactory. Many of these areas with morainic topography have been mapped in the course of the present survey and are shown on the accompanying map (Map No. V). It has not been possible to work out any definite system of morainic belts for these areas, the majority of which are confined to the preglacial valleys and cannot be traced onto the upland.

In the Scioto Valley in central Ohio Leverett[1] recognized three definite morainic belts between the main morainic system and the Wabash Moraine, but it has not been possible to distinguish these belts in Wayne County. Concerning the area between the main morainic system and the Wabash Moraine in the "shoulder" east of the Scioto lobe he says, "there is, between the morainic system and a series of moraines which follow the continental divide, a hilly district covering southwestern Summit, southeastern Medina, northern Wayne, and central Ashland counties, in which occasional small tracts were noted that have morainic topography, but the greater part of which is nearly free from drift knolls and covered with but a thin drift deposit. It is thought that these small morainic tracts are the correlatives of the feeble though well-defined moraines which appear in the northern part of the Scioto Basin. These moraines are easily traceable in the smooth Scioto Basin, but in this hilly district would be recognized only by

[1]Leverett, Frank, U. S. Geol. Surv., Mon. 41, 1902, p. 436.

very careful tracing. The ice sheet appears to have formed less continuous ridged or morainic deposits in this district than in the Scioto Basin, for, after careful examination, the writer has been unable to connect into a belt the several patches of morainic topography which were observed."

The upland west of Killbuck Valley in Chester and Plain townships shows very few morainic areas and none are indicated on the map. Southwest of the village of Jefferson in the southern part of sections 10 and 11, Plain Township, there are a few low drift knolls which rise above the general level of the country.

Killbuck Valley south of Wooster is the site of several morainic areas which apparently are not closely associated with the main morainic system. On the east valley wall in sections 22, 27, and 33, Franklin Township, morainic tracts extend from the upland out to the edge of the flood plain. The surface is quite billowy, with numerous knolls and depressions with local relief of 15 to 30 feet. Out on the valley floor there are a number of drift hills entirely surrounded by alluvial deposits, some of which barely protrude through the flood plain while others rise from 20 to more than 60 feet above the floor of the valley. These hills may be remnants of morainic loops which crossed the valley but have now been partly buried by alluvium or removed by erosion. The drift hills do not reappear on the west valley wall, unless the gravelly material of the pit in Section 29, Wooster Township, is in part of the morainic loop.

Two feeble morainic loops cross Apple Creek Valley north of the main morainic system. One of these is just west of the village of Apple Creek and consists of a number of discontinuous areas of gravelly knolls on both sides of the valley. A few low drift hills are found at various places on the flat in sections 32 and 33, East Union Township; however, the hill in the northern part of these sections is rock with a thin veneer of till. The other morainic loop crosses the valley in the southern part of Section 18, East Union Township, and is much feebler in its development than the one near the village of Apple Creek. On the east side of Apple Creek there is an area of low gravelly knolls which are in marked contrast to the surrounding even topography, whereas on the west side of the stream a billowy surface which becomes smoother to the west indicates the continuation of this feeble moraine. No other morainic loops are developed to the north in this valley.

A more pronounced morainic area is found to the northeast of the village of Apple Creek in sections 15, 22, 23, and 27, East Union Township. This area may belong to the main morainic system, but because of its location 2 or 3 miles north of that belt, it is here considered separately. The surface varies from billowy to knob and sag topography typical of a recessional moraine. To the north of the area outlined on the glacial map a feeble development of low

knolls and depressions can be observed in Section 16, and also in the northwest part of Section 10 near East Union. The adjacent upland is notably free from morainic knolls.

In Little Chippewa Valley there are a number of minor morainic areas. One of these, just southwest of Orrville, is a narrow gravelly clay ridge which crosses the preglacial valley and is the divide between the drainage of Sugar Creek and Little Chippewa Creek. This loop joins a morainic area which extends north for about 1½ miles along the west wall of Little Chippewa Valley. A somewhat similar belt extends from the north valley wall in Section 12, Green Township, into the lowland in sections 7 and 18. The surface of the belt is made up of knolls and ridges with intervening poorly drained depressions, and the drift is more sandy than is characteristic of the ground moraine in adjacent areas.

A third morainic belt crosses Little Chippewa Valley in sections 33 and 34, Milton Township. On the west side of the stream it is represented by a few low gravelly knolls, and cannot be traced onto the upland, while on the east the morainic area is much broader and extends well out into the valley so that at one place the flood plain is not more than 500 feet wide. The moraine extends for more than a mile to the east on the upland. Between the highway and the creek in the west half of Section 34, Milton Township, the surface consists of numerous knolls and depressions, but east of the road it is a rather definite ridge, elevated about 25 feet above the adjoining country. In the NE. ¼ NE. ¼ Section 34, this belt makes a sharp turn to the northwest, and continues with a slightly billowy topography to the section line, beyond which there are no morainic knolls or depressions of any consequence on the upland. South of the moraine there are level-topped terraces which continue to the southward for several miles and are composed commonly of stratified sand and gravel and laminated clays, although in places till is associated with the assorted drift. Since these terraces are not developed in the valley north of the moraine, they were probably formed in part at least by waters flowing from the ice during its halt at the position of the moraine.

A small morainic area is located in Chippewa Valley in Section 17, Milton Township, a short distance south of Sterling. Associated with the till of this area is considerable stratified material as is shown in several gravel pits.

Several isolated morainic areas are located in the eastern townships. A low morainic tract in the valley 1 mile south of Dalton forms the divide between Newark Creek and a tributary of Sugar Creek. On the upland north of Burton City there are several areas with morainic topography, but no definite relation seems to exist between them.

STRATIFIED DRIFT

Outwash

Outwash deposits consist of stratified sand and gravel laid down by streams flowing from the ice. In Wayne County such deposits are largely confined to the main valleys which served as the outlets for the waters flowing from the melting ice, hence they are valley trains.

Comparatively little outwash is associated with the main morainic system in the county, although to the south in Holmes County there are rather extensive deposits along Killbuck Valley. The only area in the southern part of the county is in sections 6 and 7, Franklin Township, on which the village of Kauke is located. A gravel pit one-half mile south of the village shows 10 feet of stratified sand and gravel overlain by a weathered zone of 2 to 3 feet of gravelly clay. Exposures of slight thickness of stratified drift are shown at a number of places over the area. The isolated ridge in the northeast part of Section 18 is made up largely of sand carrying very little gravel. An exposure shows about 15 feet of laminated fine and very fine sand overlain by a gravel stratum 2 to 12 inches thick and this by 1 to 3 feet of gravelly clay. The sand is practically gravel free, although one thin gravel stratum less than 1 inch thick was noted. It is probably an isolated part of the valley train on which Kauke is located.

Elsewhere in Killbuck Valley south of Wooster outwash deposits are of limited extent and are confined to small areas along the valley walls. Such deposits are exposed in the gravel pit near the center of Section 29, Wooster Township, and also in NW. ¼ Section 16.

Near Wooster there are two areas of outwash, both of which consist of shallow stratified deposits resting on till. One area is in the southeastern part of the city of Wooster, the other is in the southern part of Section 5, Wooster Township. At the latter place about 15 feet of fine gravel and sand rest on till. The pebbles seldom exceed 1 inch in diameter and much of the sand is coarse. Both outwash deposits appear to be associated with morainic tracts to the north. Professor George D. Hubbard considers them delta deposits, formed at a time when Killbuck Valley was the site of a temporary lake.[1]

Near Pleasant Home in sections 25 and 36, Congress Township, is a nearly level plain sloping gently to the south which is pitted with depressions 3 to 5 feet deep. This plain is confined to the valley of Muddy Fork, and near Pleasant Home stands about 25 feet above the stream. The nature of the deposit is shown in a number of gravel pits, in one of which, located one-half mile west of the village, a total of 22 feet of stratified sand and gravel is exposed. Practically all the

[1]Hubbard, Geo. D., Ancient Finger Lakes in Ohio, Amer. Jour. Sci., Series 4, Vol. 25, 1908, p. 242.

gravel pebbles are less than 2 inches in diameter, and some beds are made up almost entirely of flat rounded pieces of black shale, ranging in size from one-half to one inch in diameter. The northern border of the plain is but a short distance south of the Wabash Moraine. Apparently this deposit is outwash that was laid down during the time the Wabash Moraine was forming.

Several terrace-like areas underlain by assorted material are located along the east side of Muddy Fork Valley. These are most extensively developed where tributary streams emerge from the upland onto the valley. The following section from a gravel pit 1¼ miles south of Blachleyville is typical of these deposits.

	Feet	Inches
Brown gravel and clayey sand	3	--
Yellow laminated, very fine sand and silt	3	4
Fine sand and gravel	1	10
Yellowish brown very fine sand	2	4
Dark gray very fine sand and silt	---	10

As is shown in this section the deposits contain a comparatively large percentage of sand, more than is found in the Pleasant Home gravel and sand plain. Hubbard calls these alluvial fan deposits[1] formed at places where streams flowed in when a temporary lake occupied the valley, following the retreat of the ice, and the evidence seems to favor this explanation. The terrace one-half mile north of Funk is made up of gravelly sand to a depth of 3 feet and appears to be outwash.

The valleys in the eastern part of the county have many stratified deposits, the surfaces of which are level and appear as terraces. These deposits are very complex in their nature and show a succession of gravel and sand, slack water silts and clays, and till. Along Sugar Creek Valley there are many such deposits which are in part of water origin, but appear in places to have a thin mantle of unassorted drift over the stratified beds. There are considerable areas of outwash along Little Chippewa Valley. South of the moraine which crosses this valley in Section 34, Milton Township, there are terrace-like areas on either side, which are made up largely of stratified sand and gravel and in places lacustrine clays.

In Chippewa Valley from the county line near Creston southward beyond Sterling there are low sandy knolls and sandy clays resting on the silt and clay deposits which fill the valley. These deposits are probably outwash from the ice edge which crossed the valley a few miles north of the county line near Seville during the time the Wabash Moraine was forming. The low knolls are possibly the result of wind action.

[1]Hubbard, Geo. D., Amer. Jour. Sci., Series 4, Vol. 37, 1914, p. 445.

Lacustrine deposits

As the ice advanced and closed the channels of the northward-flowing streams the valleys became the sites of temporary lakes which persisted until an outlet was opened to the south or until the ice overrode the surface. With the withdrawal of the ice, moraines deposited in the valleys closed the outlet for drainage to the south and again the valleys became the sites of lakes, which persisted for various lengths of time. These conditions favored the formation of lacustrine deposits such as laminated clays and silts, beach deposits, and others.

Deposits of lacustrine origin, formed evidently during glacial or interglacial times, exist in all parts of the county. They commonly consist of pebble-free clay and laminated silt and very fine sand, and are overlain in places by outwash, elsewhere by unstratified drift. The deposits exist as much as 50 feet above the present streams. A number of typical exposures in various parts of the county will be noted: In SW. ¼ Section 20, Chippewa Township, a cut along the roadside shows pebble-free laminated clay and silt overlain by 7 feet of unassorted drift; similar exposures of lacustrine clays may be observed at a number of places adjacent to Red Run in the southern part of Chippewa Township at an elevation slightly greater than 1,000 feet above sea level, or 50 feet above the stream in Chippewa Valley.

Exposures of slack water deposits are numerous in Sugar Creek Valley south of McQuaid near which on the north side of the Lincoln Highway a cut shows 3 feet of laminated very fine sand and silt with a maximum elevation of 1,030 feet. Two miles southwest in SW. ¼ Section 16, Sugar Creek Township, a cut along the roadside shows the following succession:

		Feet	Inches
3.	Laminated silt and very fine sand	3	--
2.	Gravel and sand	1	6
1.	Blue gray, pebble-free lacustrine clay	9	6

A bank on the north side of the ravine near the center of Section 21, Sugar Creek Township, shows a markedly different succession of beds. Here the layers are inclined at a rather steep angle toward the main axis of Sugar Creek Valley. The presence of till over the deposits shows that they are not postglacial in origin. The position of the beds is shown in plate No. II and the following section shows the nature and thickness of the various zones.

		Feet	Inches
5.	Yellowish brown till	5	--
4.	Blue gray clay, without pebbles	2	--
3.	Laminated, fine sand	2	6
2.	Gravel and sand	3	--
1.	Compact, blue, pebbly till	5	--

Similar exposures exist in Killbuck and Muddy Fork valleys. The lacustrine clays are almost invariably associated with stratified sand and gravel, and must have been deposited by a temporary ponding of the waters which drained into the valleys.

The lacustrine deposits, existing at relatively high levels, evidently were formed prior to the final retreat of the ice from the region and hence are glacial or interglacial. This is shown by their being covered in places with till. Interbedding with outwash sand and gravel is nearly everywhere shown.

During the final withdrawal of the ice, recessional moraines dammed the valleys, and formed temporary lakes which left a record in the form of beach lines and lake bottom deposits. Four such lakes in Wayne County have been described by Hubbard[1] and are called by him "ancient finger lakes."

The best development of lacustrine deposits exists in the large valley in the western part of the county, which evidently was the site of a postglacial lake for a considerable length of time. The waters were held in the valley by a morainic dam which closed the southern end. The narrow valley to the west of the county which is the present outlet for the drainage was also closed by drift accumulations. Hubbard has named the lake which formerly occupied the valley "Craigton Lake" from the name of the village near its southern end.[2] It had a length of 18 to 19 miles and a width of three-fourths to 2 miles. Near Funk it divided into two arms one of which extended to the northwest toward Ashland and the other to the north toward West Salem.

The chief constructional features built as a result of the existence of this lake are a well defined beach, several deltas, and deposits of clay. The beach can be traced on both sides of the valley, but is better developed on the east side, especially between Blachleyville and Reedsburg. The beach is sandy with a few pebbles scattered over the surface. It forms a narrow bench which leads away to the upland, and below which a gentle slope, becoming more gentle downward, descends to the lake plain. The sand becomes finer as the valley floor is approached, and grades into the lacustrine clay of the lake plain. A stream cuts through the beach in the NW. ¼ SW. ¼ Section 17, Plain Township. At a distance of about 35 feet from the edge of the lake plain 10 feet of rather coarse sand is exposed which shows slight stratification. The upper 12 inches of the deposit is a clayey sand containing a few angular sandstone fragments, which were probably carried down onto the sand from the adjacent upland. The sand extends for about 30 feet farther in the direction of the upland but is covered with an increasing thick-

[1]Hubbard, Geo. D., Ancient Finger Lakes in Ohio. Amer. Jour. Sci., Series 4, Vol. 25, 1908, pp. 239-243; A finger Lake Bed in Ashland and Wayne Counties, Ohio, with Tilted Shore Lines, Amer. Jour. Sci., Series 4, Vol. 37, 1914, pp. 444-450.

[2]Loc. cit.

A.—Laminated fine sand, silt, and clay overlain by till. Sugar Creek Valley, Sec. 21, Sugar Creek Township.

B.—Close view of part of A.

ness of clayey material washed down from above. Comparatively little gravel is associated with the sand at this place.

Terrace-like benches occur at places where tributary streams enter the valley. Blachleyville is built on one and there are several others both north and south of this village. These benches are made up of stratified sand with varying amounts of gravel and are probably delta deposits.

The floor of the valley is largely covered with clay and organic deposits, peat or muck. In the southwest corner of Section 32, Plain Township, the lacustrine clay was formerly used in the manufacture of brick and tile. The "islands" which are located in the valley north of Craigton have a surface covering of very fine sand which is of lacustrine origin.

Hubbard[1] found that the beach lines rise to the north at a rate of 4 feet to the mile, and attributed this to a tilting of the region subsequent to the formation of the beaches.

A second lake occupied Chippewa Valley in the northeastern part of the county. Evidence of beach lines is very meager, but there is in places on both sides of the valley near Rittman a narrow sandy belt which probably marks the location of the border of the lake. The floor of the valley is largely covered with recent alluvium and sandy outwash, but a lacustrine clay is exposed in places. A bed of pebble-free clay 3 feet in thickness is exposed in a ditch south of the highway in the north central part of Section 18, Milton Township, and is overlain by sandy outwash. A similar clay bed forms the surface in the NW. ¼ Section 6, Milton Township. This lake resulted from the damming of the valley by a moraine just east of the county line near Canal Fulton in Stark County. It had a length of 20 miles and a maximum width of 4 miles.

Newman Creek Valley east of Orrville, which is now the site of a great peat bog, contained the third lake. The floor of this valley is made up of clay and peat, and at a few places there is some evidence of weak beach lines along the sides of the valley. The morainic dam was probably located a short distance east in Stark County.

The other lake recognized by Hubbard was in Killbuck Valley, and the dam which ponded the waters was near Holmesville in Holmes County. Deposits of clay and peat are found on the valley floor, but are covered in part by recent alluvium. There is little evidence of beach lines. Hubbard[1] considers that the terrace at the mouth of Spring Run is a delta built out into the lake.

[1]Hubbard, Geo. D., Amer. Jour. Sci., Series 4, Vol. 37, 1914, p. 448.

PLATE III.

A.—Rubble washed onto the highway on the valley road north of Overton.

B.—Killbuck Valley in time of flood. This valley was the site of a temporary postglacial lake.

CHAPTER III

RECENT DEPOSITS

FLOOD-PLAIN DEPOSITS

Following the withdrawal of the continental ice sheet from the region, streams began active work of erosion, and have continued it to the present time. Valleys have been cut in drift and rock, and over the valley bottoms the streams have laid their deposits.

The flood-plain deposits can be classed in two groups, between which there is every stage of gradation. In the first group are deposits of streams of high gradient descending from the upland which have dropped coarse gravel, cobbles, and rock fragments, giving rubble-like deposits along their lower courses. Such accumulations are common along many of the minor valleys of the region.

The second group of deposits is formed on the broad bottoms of the larger streams and especially in the broad preglacial valleys. They consist of clay, silt, and sand brought in by flood waters, which at times cover the whole valley floor. These deposits vary from place to place, dependent on the nature of the material carried down from the surrounding uplands and on the rate of flow of the water. The color varies from brown to black according to the amount of organic matter contained. In places peat and muck have been formed in the more poorly drained areas. At many places a deposit of 12 to 20 inches of brown silt and clay overlies beds of peat, the alluvium having been deposited during times of extremely high water.

The most extensive areas of alluvium are along Muddy Fork and Killbuck creeks in the western part of the county, and Chippewa, Newman, and Sugar creeks in the eastern part. The flood-plain of Muddy Fork exceeds 1½ miles in width near Funk; Killbuck Valley varies in width from an eighth of a mile near Overton to a mile and a quarter near Kauke. The flood-plain of Chippewa Creek is in places wider than that of any other stream in the county, but it varies from place to place and is narrowest where the stream leaves the county.

ALLUVIAL FANS

Alluvial fans have been built up at many places where streams with high gradient emerge upon the level bottoms of the larger valleys. These deposits consist of coarse gravel and angular sandstone and shale fragments spread out fan-shaped. The slope of the surface is

variable, being just perceptible in some of the larger fans, and steeper in the case of those which are smaller.

Although deposits of the alluvial fan type are to be observed in all parts of the county, they have their best development along Killbuck Valley northwest of Wooster. There the valley walls commonly have only a thin veneer of drift and hence most of the tributary streams are cutting in rock and are carrying large quantities of it to the main valley where they have built fan-shaped mounds. One of the largest alluvial fans is at the entrance to Funk's hollow, 1 mile south of Overton Station. It spreads over half way across the valley with so gentle a slope that it is barely perceptible to the eye. As a result the fan has forced the stream to the east side of the valley. Numerous other alluvial fans of various sizes may be found along this valley.

The large amount of debris carried down by these tributary streams and deposited along the borders of the main valley, causes much difficulty in maintaining the valley highway. A single heavy rain may result in the deposition of 4 to 8 feet of rubble on the road. Because of the difficulty of maintaining bridges and culverts, it is a common practice to lay a concrete runway on the road and thus lead the waters across. As the small lateral streams in places occupy the highest part of the fan it is not uncommon to find the bridges or waterways at the higher places along the road rather than in the depressions between fans.

ORGANIC DEPOSITS

The floors of many of the broad valleys are swampy in places and organic deposits, consisting of peat and muck, underlie several of the preglacial valleys. The largest area of peat and muck in the western part of the county is in the vicinity of Craigton. This area extends for about 5 miles north and south and has an east and west dimension of one-half to three-fourths of a mile. The southern part of the area is very irregular in outline, as a result of the numerous morainic knolls and ridges which lie along its border. The deposit consists of black organic material which varies in thickness from 2 to 20 feet and is found in the southern end of a large valley which was the site of a temporary lake.

In Killbuck Valley there are a number of areas of organic deposits; in fact all stages of development of these are well shown, from swamp beds to peat and muck. Some of the areas of organic deposits in this valley have been covered in part with a layer of alluvium, varying in thickness from 1 to 2 feet. Large areas of peat and muck occur also in the Orrville Swamp which extends from Orrville almost to Burton City, a tract around Fox Lake in the northeastern part of Baughman

PLATE IV.

A.—The col in Killbuck Valley north of Overton.

B.—Gently sloping alluvial fan at the mouth of Funk's Hollow, one mile south of Overton.

PART II

STRATIGRAPHY

CHAPTER IV

MISSISSIPPIAN SYSTEM

The rocks exposed in Wayne County are all late Paleozoic sedimentaries belonging to the Mississippian and Pennsylvanian systems. They include sandstone, shale, clay, limestone, and coal. In the following geologic column of the rock formations of Ohio, those which are exposed in Wayne County are printed in italics:

The Geologic Column of Ohio

System	*Formation*	
Permian	Dunkard formation	
Pennsylvanian	Monongahela formation	
	Conemaugh formation	
	Allegheny formation	
	Pottsville formation	
Mississippian	Maxville limestone	
	Logan formation	Waverly series
	Cuyahoga formation	
	Sunbury shale	
	Berea sandstone	
	Bedford shale	
Devonian	Ohio shale	
	Olentangy shale	
	Delaware limestone	
	Columbus limestone	
Silurian	Monroe formation	
	Niagara formation	
	Brassfield limestone	
Ordovician	Richmond formation	
	Maysville formation	
	Eden shale	
	Trenton limestone	

The unusually large number of rock exposures in the county, especially for a glaciated region, has greatly facilitated the study of the

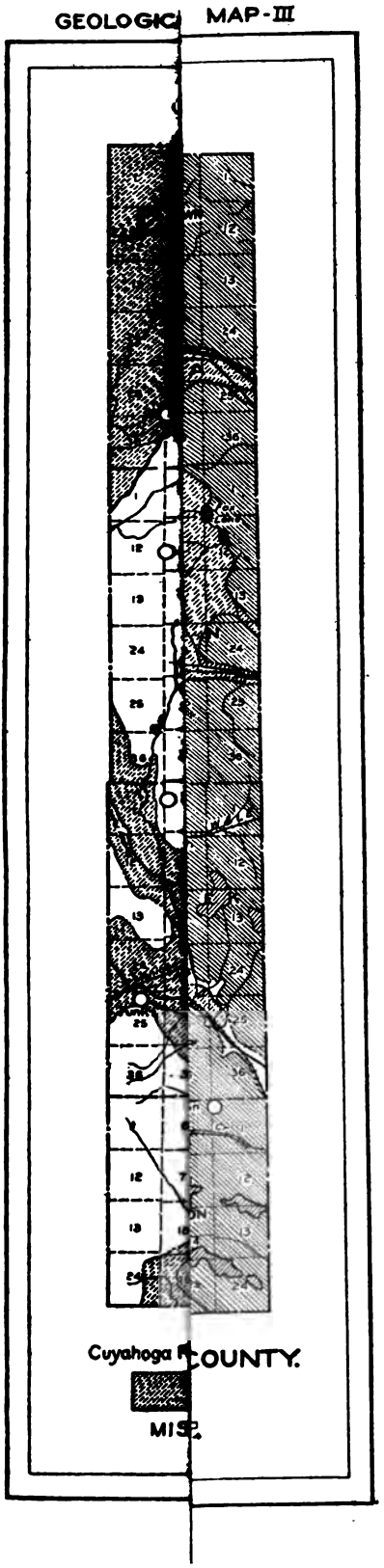
stratigraphy. Outcrops are numerous in ravines tributary to the large valleys which cross the county in various directions. This is especially true of Killbuck Valley, and also of Muddy Fork Valley, Chippewa Valley, Sugar Creek Valley, and others.

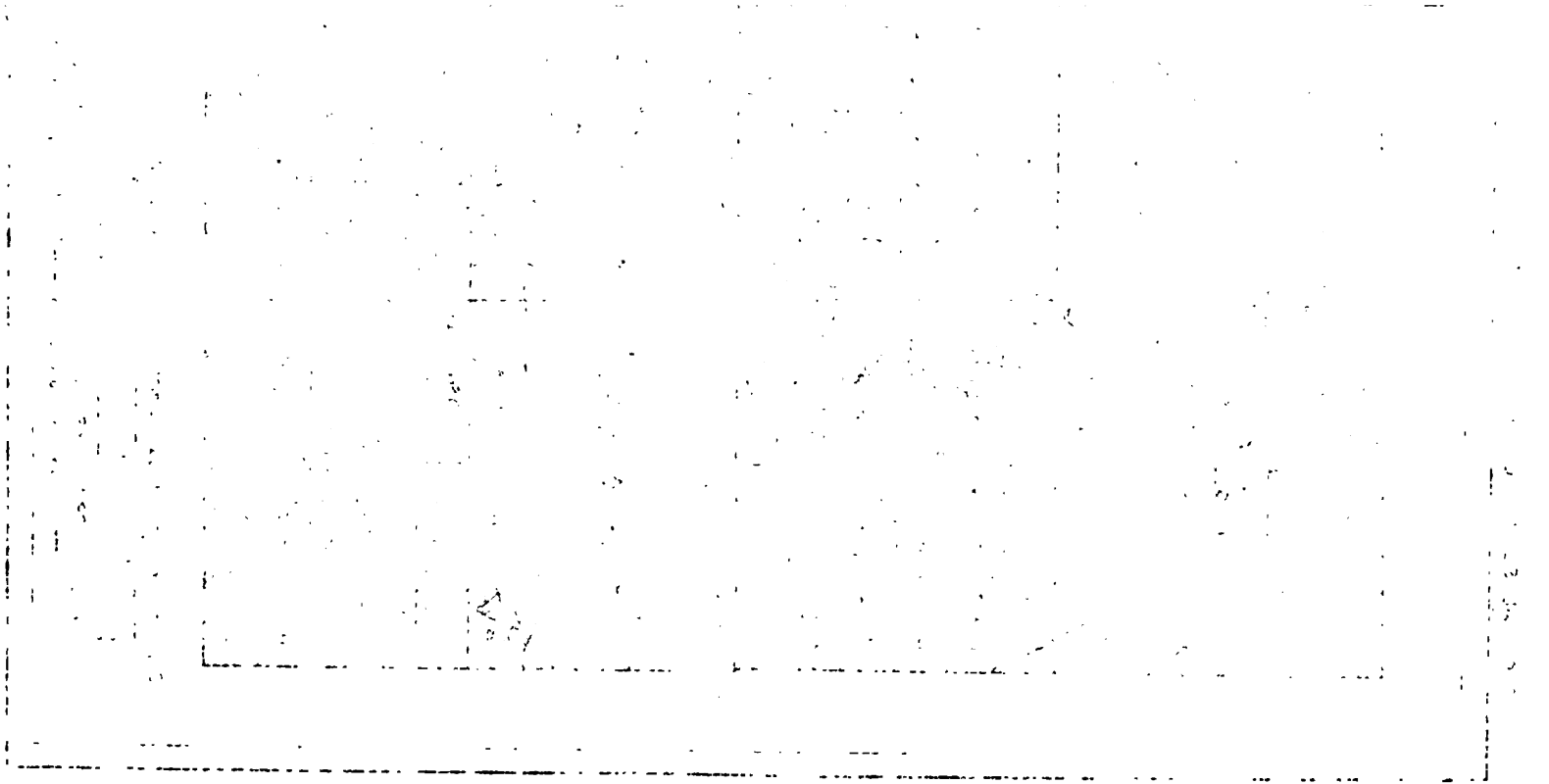
Something of the nature of the formations underlying the county, but not exposed, has been learned from drill records of several hundred gas and oil wells ranging in depth from 2,800 to 4,000 feet. The succession, the thickness, and the lithology of these formations are shown in the following generalized section. A description of the unexposed formations is given in the chapter on Economic Geology under the discussion of oil and gas.

Generalized section of formations penetrated in Wayne County in drilling for oil and gas

Mississippian System		Thickness in feet
Logan formation Cuyahoga formation Sunbury shale		400–650
Berea sandstone		5–60
Bedford shale		
Devonian System	"Ohio shale"	1135–1600
Ohio shale		
Delaware limestone Columbus limestone		
Silurian System	"Big lime"	1030–1380
Monroe formation Salina formation Niagara formation Brassfield limestone		
Medina formation		
Shales and limestone		150–170
"Clinton sandstone"		5–44
Red rock		

Rocks of Mississippian age form the surface beds over about three-fourths of the county, being exposed in the central and western parts, where they are the surface formations of the uplands and valleys, and along the lower walls of certain of the larger valleys in the eastern part where the Pennsylvanian formations underlie the uplands. The Mississippian formations which outcrop in the county are in the upper part of the Waverly series, occurring from 350 to 600 feet above the Berea sandstone. They include fine and coarse-grained sandstone, shale, conglomerate, and a few thin calcareous strata. Following the


GEOLOGIC MAP-III
Cuyahoga
COUNTY.
MISS.



classification used by Hyde for central and southern Ohio,[1] the following members have been recognized:

Generalized Section of Mississippian Formations in Wayne County

Mississippian System	Thickness in feet
Maxville limestone. No outcrop; occurs only as cherty pebbles in Sharon conglomerate.	
Waverly series	
Logan formation	
Vinton member. Fine-grained sandstone	180
Allensville member. Conglomerate	¼–2
Byer member. Fine-grained sandstone	50–80
Berne member. Conglomerate and coarse sandstone	2–10
Cuyahoga formation	
Black Hand member. Shale, changing laterally into coarse sandstone	70–80
Armstrong member. Fine-grained sandstone. Rittman conglomerate lentil.	25–35
Burbank member. Shale and sandstone	150
Maximum total thickness	500

THE CUYAHOGA FORMATION

The Cuyahoga formation includes the interval from the Sunbury shale to the base of the Logan, but only the upper third outcrops in Wayne County. The formation is commonly known as the "Cuyahoga shale," but it contains in addition to shale a considerable amount of sandstone which varies from fine to coarse grained. The lower members of the formation which outcrop in Wayne County consist of alternating sandstone and shale, and show great variation vertically. The upper member, on the other hand, is especially characterized by changing laterally from a coarse sandstone into a shale, the sandstone being developed in the eastern part of the county and the shale in the western part.

The strata of the Cuyahoga formation are exposed at many places along the main valleys of the central and western parts of the county, and also on the upland in the northern townships. Especially along Killbuck Valley north of Wooster, these beds are exposed in nearly every tributary valley and ravine. The total thickness is between 250 and 275 feet. The formation has been divided into the following

[1]Hyde, J. E., Stratigraphy of the Waverly formation of central and southern Ohio: Jour. Geol., Vol. 23, 1915, pp. 656-661. Also unpublished data.

members,—Burbank, Armstrong, including the Rittman conglomerate lentil, and Black Hand.

Burbank Member

The Burbank member, which includes the lowest exposures of the Cuyahoga formation in Wayne County, consists of alternating beds of shaly fine-grained sandstone and sandy shales, varying in thickness from 2 to 10 inches with a few beds uniform in lithology of about 20 inches. The sandstones are grayish-buff in color and the shales grayish-blue. The total thickness of the member exposed is about 150 feet.

This member is named from Burbank in the northern part of Wayne County. The exact correlation with members recognized in northern or central Ohio has not been made, but its relation to formations of northern Ohio can be determined in a general way by comparing the elevations above the Berea sandstone. In Wayne County the lowest outcrop is about 370 feet above the Berea (gas well records). Prosser reports[1] that the formations overlying the Berea sandstone near Cleveland are the Orangeville of 155 feet thickness, and the Royalton of 165. The Sharon conglomerate of the Pennsylvanian System is above the Royalton. This thickness of 320 feet is less than the Berea-Burbank interval in Wayne County, and therefore the Burbank member is either the equivalent of the upper part of the Royalton of northern Ohio or is above it.

The relation to formations of central Ohio can best be determined from the position of the Burbank member with reference to the overlying Black Hand, which is considered to be the equivalent of the Black Hand of central Ohio.

Hyde[2] places in the Raccoon member, the strata underlying the Black Hand near Newark. He reports that so little is known of the shales and sandstones below the Black Hand that it cannot be safely urged as a permanent formational name. It seems probable that the Burbank member of Wayne County may be the equivalent of part of the Raccoon of central Ohio.

The lowest outcrop of the Burbank member is in the bed of Killbuck Creek just west of Burbank where the stream flows through a rocky gorge for about a mile. Drill records show that this lowest outcrop is about 370 feet above the Berea sandstone. At this place and continuing west for about three-fourths mile the creek is flowing over sandstone with very little shale. Just west of the township line at Burbank this sandstone has a thickness of 5 to 10 feet, and occurs in beds varying in thickness from 4 to 10 inches. Certain bedding surfaces show ripple marks with a direction of North 40° West. Several of the beds are quite fossiliferous, one of the most characteristic species being *Productus newberryi* Hall. This form has been mentioned by

[1]Prosser, C. S., Geol. Survey of Ohio, Fourth Series, Bull. 15, 1912, p. 74.
[2]Hyde, J. E., Stratigraphy of the Waverly Formations of Central and Southern Ohio, Jour. Geol., Vol. 23, 1915, p. 681.

Prosser[1] as abundant in the sandstone of the Royalton formation about a mile southwest of Weymouth in Medina County. It is probable that this sandstone near Burbank should be considered as the upper part of a lower member of the Cuyahoga formation, since it is more largely sandstone than is typical of the Burbank member. About one-fourth mile west along Killbuck Creek is another exposure of this phase of the Burbank. In the following section compiled from exposures on the north and south sides of the stream at this place, Nos. 1 and 2 represent the basal sandstone phase.

Section compiled from exposures on the north and south sides of Killbuck Creek in NE. ¼ Section 1, Congress Township

Burbank member.		Feet
5.	Alternating sandstone and shale	44
4.	Covered	3
3.	Sandstone and shale alternating in beds of 2 to 4 inches	5
2.	Thin-bedded sandstone in beds of ⅛ to ¼ inch thickness, in places thickening to 6 inches	3
1.	Massive, fine-grained, buff sandstone in beds 4 to 18 inches, bedding irregular At one place a shale lens thickens to 3 inches. Sandstone in bed of stream	4

Farther west in the central part of Section 1, Congress Township, at the ford on the north-south road there is an excellent exposure of the Burbank on the south valley wall and along the road to the south, where in all there is about 70 feet of alternating sandstone and shale. A calcareous lens with a total length of about 25 feet and a maximum thickness of 10 inches was noted at one place. The lens-like form of the beds is an important characteristic of this member.

The Burbank member is well exposed in a gully along the road on the east side of Killbuck Valley, 1 mile south of Burbank Station. The following section, measured at this place, shows very well the variable lithology of this member, and brings out the fact that beds of 1, 2, and 4 inches thickness are a predominating feature.

Section along road, south side of Section 2, Congress Township

Armstrong member.		Feet
7.	Fine-grained, grayish-buff sandstone with a small amount of shale	12
Burbank member.		
6.	Shale only partly exposed	8
5.	Very thin-bedded sandstone with some alternating shale	25
4.	Sandstone with some shale	3
3.	Alternating sandstone and shale, in part covered	4
2.	Covered	10
1.	Alternating sandstone and shale in beds of varying thickness up to about 24 inches	82

[1]Prosser, C. S., Geol. Surv. of Ohio, Fourth Series, Bull. 15, 1912, p. 508.

The variable character of zone No. 1 in this section is shown in the following summary which gives the number and the range in thickness of the alternating sandstone and shale beds.

	Number of beds
Beds over 24 inches in thickness	4
Beds 12 to 24 inches in thickness	11
Beds 10 to 12 inches in thickness	5
Beds 7 to 10 inches in thickness	8
Beds 5 and 6 inches in thickness	18
Beds 3 and 4 inches in thickness	29
Beds less than 2 inches in thickness	43

The total thickness of the Burbank member in this section is 132 feet. The elevation of the base of this exposure is about 12 feet higher than that of the base along Killbuck Creek just west of Burbank. Allowing also for the normal dip to the south, which will be shown to be slightly more than 10 feet to the mile, the total thickness of the exposed part of this member is at least 150 feet.

On the west side of Killbuck Valley, due west of where the last section was measured, a ravine crossing from Section 3 into Section 10 of Congress Township shows very good exposures of these beds. Zones 1 to 4 in the following section outcrop north of the wagon road, the others to the south. Although quite different in detail from the section just given, its general characteristics are the same. It shows very well the upper part of the Burbank member which has a tendency to become shaly. Further in passing from this member to the next above, which is a sandstone, there is a transition zone made up of alternating layers of sandstone and shale.

Rock succession along the west side of Killbuck Valley in sections 3 and 10 of Congress Township

	Feet	Inches
Black Hand member.		
17. Gray blue shales with a few ironstone concretionary layers. Exposed on slope west of private road	30	--
Armstrong member.		
16. Massive gray to buff fine-grained sandstone	17	--
Burbank member.		
15. Sandstone with 5 to 10 per cent of shale (transition beds)	8	--
14. Covered	12	--
13. Shale, grayish blue with about 20 per cent of fine-grained sandstone in beds ½ to 1 inch	15	--

Burbank member—Concluded.		Feet	Inches
12.	Covered	1	--
11.	Sandstone, fine-grained, grayish yellow	---	4
10.	Shale with 25 per cent sandstone in 1 to 2 inch beds	6	--
9.	Fine-grained sandstone with thin shale partings	1	3
8.	Dark gray shale	1	6
7.	Fine-grained, grayish-brown sandstone	---	8
6.	Grayish-blue shale, with a few sandstone layers 1 to 2 inches thick	17	--
5.	Fine-grained sandstone and shale alternating, in about equal amounts, in beds of ½ to 1½ inches	10	--
4.	Grayish-blue shale with a small amount of sandstone	2	6
3.	Grayish brown, fine-grained sandstone with thin shale layers	2	2
2.	Dark gray, gritty shale with thin sandstone beds	2	8
1.	Fine-grained, gray sandstone	2	8

Southward along Killbuck Valley the upper part of the Burbank member is exposed in nearly every ravine. The shaly portion and the transition beds are well shown in the lower end of Cedar Run near Overton, where, near the first bridge west of the village there is 7 feet of shale overlain by 18 feet of alternating sandstone and shale. The most southerly exposure is near the mouth of Clear Creek Valley about 1½ miles northwest of Wooster where 25 feet of alternating sandstone and shale outcrop on the west valley wall. The upper part of the member is not exposed in this ravine.

West of the Killbuck drainage basin there are no exposures of the Burbank strata. To the east of Burbank there are several exposures of 10 to 15 feet thickness while just north of the county line, near Section 5, Canaan Township, the railroad grade has been cut for a short distance in sandstone and shale belonging to this member. Farther east there are no outcrops until Section 9, Milton Township, is reached, where there is exposed along the Sterling-Rittman pike (1¼ miles east of Sterling) several feet of alternating sandstone and shale which probably belong to the Burbank.

Fossils.—The Burbank member contains many fossiliferous horizons, and in places the surface of the thin sandstone, layers is literally covered with fossils. The thick bedded sandstone, which rises a few feet above stream level just west of Burbank and forms the basal portion of the member, contains a fossiliferous zone from which were obtained the following:

Segments of crinoid stems.
Camarotoechia contracta (Hall).
Chonetes tumidus Herrick.
Chonetes n. sp.
Productus newberryi Hall.
Orthotetes crenistria (Phillips).
Syringothyris textus (Hall).
Conularia newberryi Winchell.
Sphenotus aeolus (Hall .

The fauna consists largely of brachiopods, among which *Productus newberryi* Hall and *Orthotetes crenistria* (Phillips) are most abundant. The small number of pelecypods is notable.

Several fossiliferous horizons occur in the thin-bedded sandstones and shales which outcrop just south of Killbuck Creek in the north central part of Section 1, Congress Township. These beds are about 20 to 30 feet above the basal sandstone horizon which is exposed near Burbank. The following were collected:

Segments of crinoid stems.
Parts of crinoid calyx.
Camarotoechia sageriana (Winchell).
Chonetes pulchellus Winchell.
Productus newberryi Hall.

The species *Chonetes pulchellus* Winchell is a common form, especially on the very thin sandstone slabs.

Armstrong Member

Overlying the alternating sandstones and shales of the Burbank member is a rather persistent sandstone horizon which has been called the Armstrong member from the excellent exposure near the village of that name. Its exact correlation with horizons recognized in northern or central Ohio has not been determined. A discussion of the correlation of the strata below the Black Hand member has been given in the description of the Burbank and the conclusions stated there apply to the Armstrong member.

Where typically developed, the beds of this member consist of about 25 to 35 feet of fine-grained, grayish-buff to greenish-buff sandstone which contains 5 to 10 per cent of shale. The lower portion of the member is rather massive, whereas the upper part is thinner bedded, but lens-like beds are common throughout the member. A typical exposure of this sandstone exists in a road cut west of Armstrong where the following section was measured.

Section measured in the road cut one-fourth mile west of Armstrong

	Feet
Black Hand member.	
4. Gray blue shale with a calcareous fossiliferous zone about 8 feet above base	18
Armstrong member.	
3. Greenish-buff, fine-grained sandstone. Lower 25 feet massive, irregularly bedded, with marked tendency toward lenticular beds. Upper portion in layers of 2 to 6 inches. Thin bands of shale make up not over 10 per cent of total thickness	33
Burbank member.	
2. Alternating beds of sandstone and shale in layers 4 to 10 inches thick	29
1. Gray blue shale	10

In Shade Creek Valley three-fourths mile north, near the center of Section 26, about 17 feet of massive fine-grained sandstone is exposed at the horizon of the Armstrong member. This is overlain by 7 feet of shale with some sandstone, above which is 4 feet of sandstone.

A mile farther north in Section 23, Congress Township, the Armstrong member is well exposed along the road on the west side of the valley. The section is as follows:

Rock succession in Section 23, Congress Township

	Feet
Black Hand member.	
4. Gray blue shales	10
Armstrong member.	
3. Heavy bedded, fine-grained sandstone, bedding irregular varying from 2 to 10 inches in thickness. Very little shale	28
Burbank member.	
2. Shale and sandstone in beds of 4 to 12 inches	30
1. Gray blue shale with thin sandstone beds, becoming more numerous in lower part	29

The base of the Armstrong member is not definite and at places part of the so-called "transition beds" in the upper part of the Burbank could be included with the sandstone above.

South of Armstrong this member is well developed along Cedar Run near Overton, and at the first bridge west of that village about 8 feet of fine-grained sandstone (Armstrong) is exposed with the transition beds (Burbank) below. Farther up the valley at the bridge near the saw mill, 21 feet of the Armstrong member outcrops, the lower 5 of which is massive and thick bedded sandstone, whereas the remainder is made up of thin bedded sandstone with about 5 per cent of shale in thin lenses. About 1¼ miles farther west at the dugway, 20 feet of strata in the upper part of this member is exposed. It consists of sandstone with shales in greater proportion than is typical for this member farther north. The beds are irregular, and in part lenticular.

The upper part of the Armstrong member is exposed along Clear Creek just north of the township line, where the stream flows almost due east through a rocky gorge. In a small gully on the south valley wall the following beds are exposed:

	Feet
Black Hand member.	
2. Gray blue shale. Fossiliferous zone about 3 feet above base	16
Armstrong member.	
1. Fine-grained, gray buff sandstone in beds varying from 1 to 10 inches	20

This is the farthest south that the member has been recognized. To the north along Killbuck Valley it is exposed in practically every rocky ravine and valley with rock walls. To the west of Killbuck the surface is everywhere above the horizon of the Armstrong beds, which to the east outcrop along the headwaters of Killbuck Creek in sections 10 and 15, Canaan Township, and are the only exposures recognized in this township.

Rittman conglomerate lentil.—Near Rittman in the northeastern part of the county, beds which have been correlated by the writer with the Armstrong member include a conglomerate stratum. In an excavation in the north part of Rittman, the following beds were exposed:

Section in the north part of Rittman

	Feet	Inches
Armstrong member.		
7. Fine-grained sandstone	2	--
Rittman conglomerate lentil.		
6. Medium-grained, grayish-buff, fossiliferous sandstone, containing few to many pebbles	1	3
5 Shale, brown, very irregular in thickness	---	4
4. Conglomerate. Coarse-grained sandstone with quartz pebbles $\frac{1}{16}$ to $\frac{1}{2}$ inch in diameter, predominating size $\frac{1}{4}$ inch	---	6
3. Coarse-grained sandstone, in part conglomeratic, with shale lenses in places at base	1	--
2. Fine-grained sandstone	2	--
1. Yellowish-green sandstone	1	4

That the Rittman conglomerate is distinct from the two conglomerates of the Logan formation to be described later is evident from the fact that it lies below the horizon of a thick shale bed outcropping in a ravine about one-fourth mile east of the village. Above the shale there is about 10 feet of coarse-grained, yellowish-brown sandstone lying at an elevation about 80 feet above the Rittman conglomerate bed. These upper coarse sandstones are assigned to the Black Hand member which would make the shales also Black Hand and the underlying sandstone the Armstrong.

Farther west no suggestion of coarse beds has been found within the Armstrong member, and near Rittman, is the only locality where the third conglomerate was observed in the county.

To the north of Wayne County along the valley of River Styx there are numerous ravines at about the correct elevation for the outcrop of the Armstrong member. The conglomerate outcrops in a ravine one-fourth mile east of Acme just north of the Seville-Wadsworth pike. At this place it consists of slabs 8 inches thick with quartz pebbles one-eighth to one-sixteenth of an inch in a matrix of coarse sandstone.

The total thickness is between 1 and 2 feet. Above the conglomerate scattered outcrops show thin-bedded, fine-grained sandstone, the thickness of which is estimated at about 20 feet. Farther up the ravine the exposures are largely gray blue shale with an occasional thin sandstone bed. Additional study in Medina County will be necessary to clear up the status of this conglomerate.

Black Hand Member

The Black Hand member overlies the sandstone strata which have been included in the Armstrong. The term Black Hand has been used from an early date as a formation name for part of the Waverly. Hyde uses the term[1] in a more limited sense in his classification of the Mississippian of central Ohio, where the Black Hand is made a division of the Cuyahoga instead of being given the rank of a formation. The classification employed in Wayne County follows Hyde's usage.

In Wayne County the Black Hand is developed in two distinct facies, a coarse sandstone and a shale, and one passes laterally into the other. The coarse sandstone is best developed in the northeastern part of the county, where it has considerable thickness and is underlain by shale and fine-grained sandstone. To the west the thickness of the coarse material decreases and the amount of fine sandstone associated with the shale becomes less. West of Killbuck Valley where the shale facies occurs, the Black Hand consists almost entirely of shale, with a total thickness of about 80 feet, and the only break occurs about 20 or 30 feet above the base, where there is about 10 feet of fine-grained sandstone. At many places the overlying Berne member (conglomerate largely) rests on the shale (Black Hand), whereas at Wooster the Berne is separated from the shale by sandstone strata which increase in thickness to the east. The lateral transition from shale to coarse sandstone is well shown in the exposures near Wooster and to the east of that city. Hyde has shown that in central Ohio there is a lateral transition from the conglomerate and coarse sandstone on the east into shales on the west.[2] The lateral transition in Wayne County appears to be similar.

The beds included in the Black Hand member have been recognized by Read and also by Cooper in their discussion of the geology of the county. In the reports by Read[3] on the geology of Wayne, Richland, Knox and Licking counties, olive shales are mentioned in the description of the Waverly, which are described as passing "into rich, thick layers of quarry rock." Cooper[4] recognized the Black

[1]Hyde, J. E., Stratigraphy of the Waverly Formations of Central and Southern Ohio, Jour. Geol., Vol. 23, 1915, p. 658.
[2]Hyde, J. E., Jour. Geol., Vol. 23, 1915, p. 680.
[3]Read, M. C., Geol. Surv. of Ohio, Vol. 3, 1878, p. 525.
[4]Cooper, W. F., The Waverly Group, Denison Univ. Bull. No. 5, 1889-90, p. 28.

Hand horizon in a section along Christmas Run near Wooster, where under Conglomerate I (Berne member of this bulletin) he reports 30 feet of shales, underlain by the same thickness of concretionary shales.

Exposures in the western part of the county.—The shale facies of the Black Hand occurs in the western part of the county, where it outcrops in many of the ravines tributary to Muddy Fork Valley and is very well exposed just west of the county line in the valley of Clear Fork south of Funk.

Just west of Pleasant Home in Congress Township, the Black Hand member is exposed in the creek bed. Two miles southwest in the northwest corner of Section 12, Chester Township, it is also exposed and the following section was measured:

Record taken west of Lattasburg in NW. ¼ Section 12, Chester Township (T22N-R15W)

	Feet	Inches
Byer member.		
6. Fine-grained sandstone	10	--
Berne member.		
5. Medium to coarse—grained sandstone, gray, in beds of ½ to 1 inch	1	--
4. Coarse, grayish-yellow sandstone with numerous quartz pebbles averaging ½ inch in diameter	---	1 to 2
3. Grayish-blue shale	---	½
2. Coarse, yellow sandstone with a few pebbles	---	3
Black Hand member.		
1. Gray blue shale with an occasional ironstone concretionary layer	20	--

Here the coarse pebbly beds of the Berne member are resting directly on the shale beds of the Black Hand.

Southwest of Funk, just west of the county line along Lake Fork, bedrock outcrops in most of the ravines, showing at a number of places the upper part of the Black Hand member. One of the best exposures is in Section 34, Mohican Township.

Strata measured in SW. ¼ Section 34, Mohican Township, Ashland County

Logan formation (undifferentiated).	Feet	Inches
15. Thin-bedded, fine-grained sandstone alternating with thin beds of shale	20	--
14. Fine-grained sandstone	4	--
13. Covered	12	--
12. Thin-bedded, fine-grained buff sandstone	10	--
11. Grayish-blue shale	1	--

Logan formation (undifferentiated)—Concluded.	Feet	Inches
10. Fine-grained sandstone	3	--
9. Thin-bedded sandstone and shale alternating	8	--
8. Alternating shale and sandstone. Shale in beds of 4 to 6 inches and sandstone in 2 inch beds	7	--
7. Dark gray shale	2	--
6. Fine-grained sandstone in beds of 2 to 14 inches with thin shale partings	17	--
Berne member.		
5. Coarse-grained yellow sandstone	3	9
4. Grayish-blue, sandy shale	---	4
3. Medium-grained yellowish sandstone	---	9
2. Conglomerate with pebbles ranging from $\frac{1}{16}$ to $\frac{1}{2}$ inch in diameter	---	4 to 8
Cuyahoga formation.		
Black Hand member.		
1. Grayish-blue shale with a few layers of ironstone concretions about 1 inch thick, in part fossiliferous	45	--

Here as at Lattasburg the conglomerate bed of the Berne is resting on Black Hand shale. The contact between the two members shows irregularities of 2 to 6 inches within 12 to 18 inches laterally which cut across the shale beds, and indicate a disconformity. About 40 years ago an entry was made for coal in the shale at the top of the Black Hand at this place and extended into the hill for 30 or 40 feet. It is needless to say that no coal was found, but the old drift is still open.

The Black Hand member wherever exposed in the western part of the county has much the same characteristics as given above. The base is everywhere under drainage, hence the total thickness could not be determined. The dip of the upper surface, which is to the south, is shown by the following elevations:

	Elevation above sea level
Pleasant Home	1,080 feet
Lattasburg	1,045 feet
Southwest of Funk	1,020 feet

The distance between the first two localities is more than 2 miles, giving a dip of about 15 feet to the mile, whereas the distance between the first and third is about 13 miles north and south and 3 miles east and west, giving a dip of about 5 feet per mile. The dip for the first 2 miles is about twice that for the next 11, an irregularity probably due to local structure.

Killbuck Valley—The Black Hand member is exposed at many places along Killbuck Valley. West of the Killbuck the shale facies is developed, whereas on the east side near Wooster the transition beds of sandstone occur in the upper part of the member.

On the west side of Killbuck Valley in Funk's Hollow (Section 23, Chester Township) the shale is exposed in considerable thickness and the relation to the overlying beds is very well shown.

Strata measured in Funk's Hollow in Section 23, Chester Township

	Feet	Inches
Logan formation.		
Vinton member.		
13. Fine-grained, yellowish-brown sandstone	20	--
Allensville member.		
12. Medium-grained sandstone with a few pebbles	--	1
Conglomerate	--	1
Medium-grained sandstone with pebbles on bedding planes	--	2
Conglomerate with quartz pebbles ⅛ to ½ inch in diameter, and pebbles of sandstone up to ½ inch	--	9
Byer member.		
11. Fine-grained sandstone	70	--
Berne member.		
10. Coarse, yellowish-brown sandstone	4	8
9. Medium-grained, brown sandstone	5	10
8. Coarse-grained, yellowish-brown sandstone	2	--
7. Conglomerate with quartz pebbles ranging from 1/16 to ¼ inch in diameter, predominately ⅛ inch	1	6
6. Coarse-grained, yellow sandstone with a few pebbles in upper part	1	6
Cuyahoga formation.		
Black Hand member.		
5. Grayish-blue shale containing several 1 inch concretionary layers, lower 10 feet slightly gritty	44	--
4. Fine-grained, grayish-brown sandstone	--	8
3. Gray, gritty shale	2	--
2. Fine-grained sandstone in beds of ½ to 6 inches with some thin shale layers	2	--
1. Yellowish-brown to reddish-brown shale at base, grading into a blue gray shale in the upper part	14	--

Zones 1 to 10 and about 25 feet of No. 11 outcrop in the first ravine on the south side of Funk's Hollow; the higher zones are exposed in a ravine about a quarter of a mile farther west.

In the above section the main conglomerate of the Berne lies a little above the shale. Zone No. 6 contains a number of pebbles and, therefore, is included in the Berne member. It is possible, however, that this zone is the thinning edge of the sandstone strata of the upper part of the Black Hand.

The numerous fossiliferous concretionary layers, 1 to 2 inches thick, are very characteristic of the shale of the Black Hand member.

A few calcareous layers, also fossiliferous, occur in this. Sandstone strata 3 to 4 feet thick are commonly present in the lower part of the shale. The brown shale in the lower part of the above section is unusual and was found at no other place. It may be the result of local weathering.

The Black Hand member is well exposed along Cedar Run northwest of Overton. In the first ravine south of Cedar Valley village its total thickness is 73 feet and it is made up almost entirely of shale with the exception of a few feet of sandstone near the base.

Farther north about 4 miles, in Shade Creek Valley, the total thickness of this member is exposed and the relationship to the beds above and below is well shown.

Strata measured in Shade Creek Valley in sections 26 and 27, Congress Township

	Feet	Inches
Logan formation.		
Byer member.		
15. Fine-grained, grayish-brown sandstone	15	--
14. Dark gray shale	--	4
Berne member.		
13. Medium-grained, grayish-yellow sandstone in beds of ½ to 1 inch	1	10
12. Coarse-grained, loosely-cemented, yellow sandstone	--	4
11. Thin-bedded, medium-grained sandstone in beds of ¼ to ½ inch	--	3
10. Medium-grained, heavy-bedded sandstone	--	9
9. Medium-grained sandstone, grayish-yellow, in beds of ½ to ¾ inch	2	6
8. Coarse-grained, yellow sandstone containing a few quartz pebbles, base undulatory	3	6
Cuyahoga formation.		
Black Hand member.		
7. Gray blue shale with a few ironstone concretionary layers of about 1 inch thickness, especially numerous in lower third	73	--
6. Fine-grained, massive sandstone	4	--
5. Gray blue shale with a few thin sandstone beds	7	--
Armstrong member.		
4. Yellowish-brown, fine-grained sandstone with a small amount of shale	14	--
3. Grayish-blue shale	7	8
2. Fine-grained sandstone	1	6
1. Grayish-blue shale	2	--

The total thickness of the Black Hand member in this section is a little greater than in the ravines to the south.

At one place where the stream is undercutting, there is more than

50 feet of shale in a single exposure. The coarse sandstone of the Berne beds forms the cap rock of the cliff. This ravine was examined shortly after a period of very high water, when much of the loose debris had been carried away leaving the stream channel almost clear for some distance. Part of the way the stream bed was in shale, and the concretionary layers, offering resistance to erosive action, formed little waterfalls. At such places there was always an abundance of fossil-bearing material. This valley next to the shale pit near Wooster, offers the best possibilities for collecting from the shale beds of any place in the county.

The character of the Black Hand along Shade Creek Valley is very similar to that along the west county line. The contact with the Berne member shows erosional undulations which indicate a disconformity. In Shade Creek Valley the conglomeratic character of the Berne is poorly developed, but the bed resting on the shale contains sufficient pebbles to indicate a conglomerate horizon.

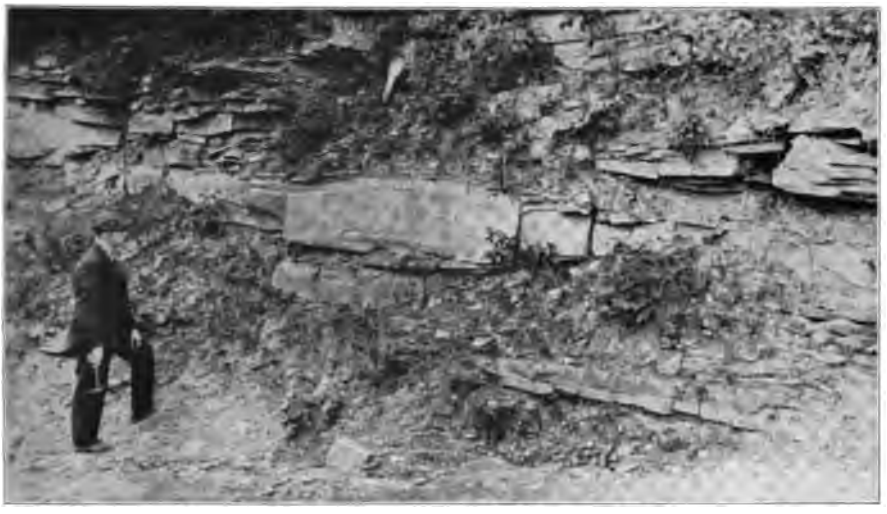
North of Section 10, Congress Township, the upper part of the Black Hand is not exposed, the shale beds forming the surface rock.

On the east side of Killbuck Valley one of the best known exposures of the Black Hand member is in the shale pit of the Medal Paving Brick Company in Section 5, Wooster Township. A section showing the beds exposed there follows:

Section measured in the shale pit of the Medal Paving Brick Company, Section 5, Wooster Township

	Feet	Inches
Drift	2 to 6	
Logan formation.		
Byer member.		
7. Fine-grained, grayish-buff sandstone. Much displaced by ice shove	2	--
Berne member.		
6. Conglomerate with pebbles ¼ to ½ inch in diameter. Much broken and displaced	1	--
Cuyahoga formation.		
Black Hand member.		
5. Coarse, yellowish-brown sandstone	10	--
4. Grayish, sandy shale, blue	--	8
3. Fine-grained, brown sandstone in beds of 1½ to 6 inches	6	--
2. Grayish-blue shale, with fine-grained, thin-bedded sandstone. Lower limit rather indefinite	5	--
1. Dark grayish-blue shale, containing a few layers of fossiliferous ironstone concretions, also thin fossiliferous, calcareous layers	33	3

PLATE V.



A.—View of Armstrong member, exposed one-fourth mile west of Armstrong, showing lenticular sandstone strata.

B.—View of the shale pit of the Medal Paving Brick Company near Wooster. Shale of the Black Hand member passes into sandstone near the top of the quarry face.

The lower part of the shales is not exposed, but a test hole sunk by the brick company is reported to have shown an additional 20 feet of shale, below which there is shale with some sandstone for 36 feet, with heavy sandstone underneath. Concretionary layers are reported to be more numerous in the lower 20 feet of shale than in the portion exposed in the shale pit.

The character of the upper portion of the Black Hand member here is much different from that on the west side of Killbuck Valley where the conglomerate bed (Berne) rests on the shale. In the above section there is a very indefinite lower limit to the sandstone beds as shown in Zone No. 2, where very thin sandstone layers begin coming into the shale, and eventually cut it out entirely. These beds appear to be conformable; in fact the presence of the lower sandstone beds would hardly be observed except on careful examination. Evidently there was no break in sedimentation until just before the conglomerate was deposited. At this place the conglomerate is so disturbed as a result of ice shove that its relation to the underlying beds is difficult to determine.

That the presence of sandstone beds in the upper part of the Black Hand is a common feature east of Killbuck Valley is also shown in the section measured in the ravine northeast from Armstrong in Section 36, Congress Township, and given on page 73. At this place eleven feet of sandstone and sandy shales separates the conglomerate bed from the shale. This same general condition is shown at a number of places along the east side of Killbuck Valley.

About 2½ miles east of the brick plant in the northern part of Section 2, Wooster Township, the upper part of the Black Hand is exposed in Coe's quarry where the following section was measured:

Strata measured in Coe's quarry, Section 2, Wooster Township

	Feet	Inches
Logan formation.		
Byer member.		
4. Fine-grained sandstone with interbedded shales	20	--
Berne member.		
3. Conglomerate, with pebbles $\frac{1}{16}$ to ¼ inch, predominating size about ⅛ inch. Upper and lower surfaces show irregular contact	1	--
Cuyahoga formation.		
Black Hand member.		
2. Coarse, yellow sandstone	3	--
1. Massive, medium-grained sandstone containing white particles which may be weathered feldspar	15	--

That this conglomerate bed (Zone No. 3) is not the Allensville member is evident from the fact that the latter outcrops at a higher elevation in sections 35 and 36, Wayne Township, where both conglomeratic

beds are exposed in close proximity. The total thickness of the sandstone beds in the upper part of the Black Hand could not be determined because the underlying shales are nowhere exposed on the north side of Apple Creek Valley. On the south side of the valley the shales outcrop along the highway in Section 2 but the upper part of the member is covered. Evidently the coarse and medium sandstone is thicker than at the brick plant west of Wooster.

Exposures east of Killbuck Valley.—To the east the Black Hand member outcrops along Little Chippewa Valley in Milton and Green townships. At Orrville the shale is reported in wells at the city waterworks. The Black Hand is exposed in Section 4, Green Township, and in Section 33, Milton.

Rocks measured in a ravine in the south central part of Section 33, Milton Township

		Feet	Inches
Logan formation.			
Berne member.			
19.	Conglomerate. A coarse sandstone matrix with pebbles up to ½ inch. Upper portion very coarse with matrix made up of 1/16 inch grains with which are pebbles of ½ inch. Fossiliferous	1	6 to 11
Cuyahoga formation.			
Black Hand member.			
18.	Coarse-grained, yellow sandstone containing plant remains	7	--
17.	Black coal streak	--	½
16.	Gray clay shale	--	3
15.	Coarse-grained sandstone with plant fragments	1	--
14.	Medium to coarse-grained, buff, even-bedded sandstone in beds of 4 to 6 inches except upper 4 feet in which the beds are ½ to 2 inches	10	--
13.	Shale, blue gray, irregularly bedded	--	6 to 18
12.	Medium-grained, yellowish-brown, thin-bedded sandstone	4	--
11.	Blue gray, sandy shale	1	4
10.	Medium-grained sandstone	2	6
9.	Coarse-grained, yellowish-brown sandstone in beds of 4, 6, and 20 inches, projecting at the waterfall	3	--
8.	Medium-grained, irregularly bedded sandstone	2	--
7.	Gray blue, gritty shale containing plant remains	11	--
6.	Dark gray, dense, medium-grained, irregularly bedded sandstone	2	2
5.	Arenaceous shale	1	3
4.	Fine-grained, gray, thin-bedded sandstone containing plant remains	3	--
3.	Gray blue shale	--	10
2.	Fine-grained, gray sandstone	1	2
1.	Gritty to clayey shale with layers of shaly sandstone. Thin sandstone layers in upper four feet, underlain by shale, below which the remainder is a gritty shale	18	4

This section presents a number of unusual features. The presence of plant remains and the thin coal streak suggests that the upper beds may be Pennsylvanian rather than Mississippian. A marine fauna (*Shizodus*) with decided Mississippian aspects in the conglomerate furnishes conclusive evidence as to the age of the beds. The great thickness of strata between the conglomerate and the shales is significant. The sandy character of the shales forms an important difference from the beds in the western part of the county. That the identification of the shales is correct is confirmed by an outcrop in the west central portion of Section 28, Milton Township, where, at a horizon slightly lower than the base of the section just given, there is a fossil bed containing a typical Black Hand fauna.

In the vicinity of Rittman the Black Hand member outcrops at several places. In a ravine in the central part of NE. ¼ Section 11, Milton Township, grayish-blue shale is overlain by coarse yellow sandstone. About 2½ miles west in the west central part of Section 4, an exposure along the highway shows 28 feet of coarse gray sandstone underlain by 30 feet of sandy shale containing many thin sandstone beds. That this sandstone is Mississippian and not Pennsylvanian is shown by the presence of such fossils as *Sphenotus aeolus* and *Shizodus triangularis*. That it is in reality a sandy phase of the Black Hand seems evident from its elevation and relation to the underlying shale as well as from the character of the fauna.

The only outcrops of unquestioned Black Hand farther east in Chippewa Township are in sections 6 and 7. Along the county line in NW. ¼, NE. ¼ Section 6 the following was measured:

Black Hand member.	Feet	Inches
6. Medium-grained, irregularly-bedded sandstone	2	--
5. Gray blue shale	18	--
4. Fine-grained sandstone	--	6
3. Gray blue shale	1	6
2. Fine-grained sandstone, fossiliferous	--	4
1. Greenish-gray shale	5	--

The fossils found in the sandstone (Zone No. 2) confirm the identification of these strata as Waverly.

The shales in the lower part of the Black Hand are also exposed in a ravine 1 mile south near the north line of Section 7. Within less than 3 miles to the southeast the Pennsylvanian sandstones outcrop at about the same elevation, showing that at the latter place the upper part of the Waverly has been removed by erosion.

Coarse sandstone beds resembling the sandstone facies of the Black Hand member are exposed in a railroad cut one-half mile northeast of

Marshallville in Section 33, Chippewa Township. A section measured near the eastern end of the cut follows:

		Feet	Inches
4.	Coarse-grained, gray sandstone with a few quartz pebbles on upper surface	8	6
3.	Bluish-gray shale, containing some iron concretions	3	--
2.	Coarse-grained, gray sandstone, upper half massive and even bedded, lower half thin and irregularly bedded	9	--
1.	Bluish-gray shale	--	6

On the eroded surface of these beds there is 20 feet or more of shale which has been deposited in a depression of the sandstone surface, showing a marked disconformity. (See Plate VIII.) The shale beds are undoubtedly of Pennsylvanian age, as is shown by the presence of thin bands of coal, but the sandstone may be either Pennsylvanian or Mississippian. If the former, then it must be the sandstone above the Sharon or No. 1 coal which outcrops about 2½ miles east at a slightly lower elevation, in which case the disconformity is within the Pennsylvanian. If the strata are Mississippian, then they must belong to the Black Hand member. The fact that the top of the Black Hand at a place 5 miles west is at practically the same elevation as in the railroad cut makes it possible that the beds are Black Hand. Waverly sandstone outcrops in the north central part of Section 32, Chippewa Township, also in SE. ¼ Section 33. The evidence seems to indicate that these coarse sandstones are Black Hand, and that the disconformity is the Mississippian-Pennsylvanian.

The exact extent of the sandstone facies of the Black Hand within Chippewa Township is difficult to determine. The Sharon conglomerate at the base of the Pennsylvanian is a coarse-grained conglomeratic sandstone and resembles in many ways the coarse beds of the Black Hand. It seems probable that a number of exposures of coarse-grained sandstone in the northwestern part of the township are Black Hand. This possibility must be considered in the study of the coarse sandstones to the north of the county. The coarse gray sandstone reported by the driller as occurring over the "Cuyahoga shales" at Doylestown may in all probability be an "outlier" of Mississippian age. This would account for the fact that the Sharon or No. 1 coal is wanting immediately under Doylestown, although it has been mined within a short distance on three sides of the village. There can be no question that the sandstones outcropping on the Doylestown hill are of Pennsylvanian age.

Fossils.—The Black Hand member is quite variable in fossil content in its different phases. The shale contains numbers of fossils at certain horizons, but it is often difficult to locate them. The iron-

stone concretions and calcareous layers are commonly very fossiliferous and furnish the best material. Where the sandstone facies is developed fossils are fewer in number, but are present especially in the beds of medium to fine texture, although a few beds in the coarse sandstone contain them.

In the shale pit of the Medal Paving Brick Company about 1 mile northwest of Wooster, the calcareous and concretionary layers have been sorted from the shale and have accumulated in large quantities. In a collection from this material the following fossils have been identified:

Segments of crinoid stems.
Athyris lamellosa Leveille.
Camarotoechia contracta (Hall).
Camarotoechia sageriana (Winchell).
Camarotoechia sapho (Hall).
Centronella flora Winchell.
Orthotetes crenistria (Phillips).
Productus raricostatus Herrick.
Productus semireticulatus (Martin).
Spirifer marionensis Shumard.
Strophalosia cymbula Hall and Clarke.
Syringothyris textus (Hall).
Leioptera ortoni Herrick.
Lyriopecten nodocostatus Herrick.
Palaeoneilo attenuata Hall.
Posidonomya fragilis Herrick.
Capulus lodiensis (Meek).
Brachymetopus spinosus (Herrick).

In the upper part of the Black Hand at the shale pit, a medium to fine-grained sandstone grades through sandy shales into shale. From this sandstone the following fossils were collected:

Segments of crinoid stems.
Fenestella sp.
Chonetes pulchellus Winchell.
Orthotetes crenistria (Phillips).
Productus arcuatus Hall.
Crenipecten winchelli (Meek).
Leioptera ortoni Herrick.
Palaeoneilo concentrica var. Herrick.

It is commonly difficult to locate fossil horizons in the shale strata of the Black Hand member, but once located the fossils are abundant. In NW. ¼ SW. ¼ Section 28, Milton Township, the following forms were identified in a collection from the shale:

Segments of crinoid stems.
Fenestella multiporata var. lodiensis Meek.
Athyris lamellosa Leveille.
Camarotoechia sp.
Centronella flora Winchell.
Orthotetes crenistria (Phillips).
Productus newberryi Hall.
Productus raricostatus Herrick.
Productus sp.
Syringothyris textus (Hall).
Crenipecten winchelli (Meek).
Palaeoneilo concentrica var. Herrick.
Pernopecten aviculatus Swallow?
Posidonomya fragilis Herrick.
Promacrus andrewsi (Meek).
Solenomya? cuyahogensis Herrick.
Conularia newberryi Winchell.
Orthoceras sp.

The coarse sandstone which forms the upper part of this member in the eastern part of the county ordinarily is not very fossiliferous. Along the highway in the central part of Section 4, Milton Township, a small collection was made from the coarse sandstone, which included the following:

Segments of crinoid stems.
Schizodus cuneus Hall.
Schizodus triangularis Herrick.
Sphenotus aeolus (Hall).

THE LOGAN FORMATION

The Logan formation consists of a great thickness of fine-grained sandstones with a small proportion of interbedded shales and is far more uniform in its lithology than the Cuyahoga formation. The only notable deviations from this uniformity are a conglomerate member (Berne) at its base and a widely distributed conglomerate member (Allensville) at 50 to 80 feet above the base. The Logan has been subdivided as follows:

Logan formation.
- Vinton member.
- Allensville member.
- Byer member.
- Berne member.

Berne Member

The Berne member consists of marine conglomerate and coarse and medium-grained sandstone, and has a total thickness varying from 2 to

10 feet, although the conglomeratic portion seldom makes up more than 1 to 3 feet of the total thickness. In places there are two conglomerate beds, separated by coarse sandstone. It is everywhere disconformable with the Black Hand beds beneath. The interval between the Berne and Berea, as determined from the logs of oil and gas wells and the elevation of the outcrop of the former, varies from 566 to 635 feet, which is the approximate thickness of the Cuyahoga formation in the county.

The term Berne was given by Hyde to a conglomerate bed at the base of the Logan formation in Berne Township, Fairfield County,[1] and the beds of Wayne County are believed to be its equivalent.

Because of the distinctive lithology, these beds were early recognized and used as a horizon marker. Cooper in discussing[2] the geology of the Waverly of northern Ohio reports several sections measured in Wayne County, and gives Conglomerate I a thickness of 1 foot in Christmas Run near Wooster and of 3 feet in Funk's Hollow.

Lamb has described[3] these beds as the Lower Conglomerate. The thickness along Killbuck Creek is given as 2 to 20 feet with a thickening eastward to 30 or 45 feet before they pass under cover. "At every point where the base was well exposed, the pebbles and cobbles rest upon blue shale, with the contact sharp and generally with very conspicuous undulations. The remainder of the conglomerate stratum is largely a coarse sandstone with streaks of fine pebbles." He points out that the dip of the Lower Conglomerate is almost exactly the same as the Berea sandstone from Berea to Apple Creek, 11 feet per mile. From his description it seems probable that Lamb has included in his Lower Conglomerate some of the sandstones which in this bulletin are placed in the upper part of the Black Hand.

The most constant feature of the Berne member in Wayne County is the conglomerate, which at places breaks into two beds separated by sandstone. The variations in detail from place to place are marked, but no greater than would be expected in a formation of this character. West of Killbuck the conglomerate commonly rests on Black Hand shale. Above the distinctly conglomeratic layers there is a variable thickness of coarse sandstone, which is here included in the Berne member. To the northwest of Wooster the total thickness diminishes and the conglomeratic character is not so marked.

East of Killbuck Valley the Berne member commonly consists of a bed of conglomerate resting on the coarse sandstones of the Black Hand, and overlain by fine-grained sandstones of the Byer member. The only exceptions to this are in the eastern part of Congress Town-

[1]Hyde, J. E., Stratigraphy of the Waverly Formation of Central and Southern Ohio, Jour. Geol., Vol. 23, 1915, p. 676.

[2]Cooper, W. F., The Waverly Group, Bull. Denison Univ., Vol. 5, 1889-90, p. 26.

[3]Lamb, G. F., Middle Mississippian Unconformities and Conglomerates in Northern Ohio, Ohio Naturalist, Vol. 14, 1914, p. 344.

ship where the beds show a close resemblance to those west of the Killbuck.

The conglomerate bed usually consists of a coarse sandstone matrix with many pebbles ranging in size from one-sixteenth to one inch in diameter, with a majority between one-eighth and one-half inch. Over 99 per cent of the pebbles are quartz. At a few places a portion of the conglomerate bed consists almost entirely of pebbles about one-sixteenth inch in diameter. There are also cobbles which vary from 2 to 12 inches in diameter and which consist of coarse or fine-grained sandstone and firm shale. These apparently were derived from the underlying beds.

The contact between the Berne member and the underlying Black Hand shows in places a disconformity which is one of the reasons for placing the Berne member in the Logan rather than in the Black Hand. Hyde has indicated[1] that lithologically the Berne member of central Ohio belongs in the Cuyahoga, but from the standpoint of historical succession its place is in the Logan. In support of this Hyde has pointed out that the base of the bed is sharp and in places shows a surface of erosion; that there is a transition from the Berne member to the Byer above; that it is a marine conglomerate quite distinct in character from the usual coarse non-fossiliferous facies of the Black Hand; that the fauna in the Berne shows closer relationships to the Byer member than to those of the Black Hand. In Wayne County the disconformity at the base and the marine fauna are thought to be sufficient evidence to justify placing the Berne member in the Logan formation.

Outcrops of the Berne member exist at most of the locations already mentioned under the description of the Black Hand. Exposures are numerous along Killbuck Valley and near the western county line.

Western part of county.—The Berne member is exposed one-fourth mile east of Pleasant Home in Section 30, Congress Township, in a ravine just north of the highway. As is shown in the following section measured at this place, the conglomerate bed is of slight thickness; however the associated coarse sandstones are slightly pebbly.

Strata measured one-fourth mile east of Pleasant Home in Section 30, Congress Township

Logan formation.

Byer member.	Feet	Inches
5. Fine-grained sandstone in beds ½ to 3 inches thick, with thin shale partings	5	--

[1]Hyde, J. E., Jour. Geol., Vol. 23, 1915, pp. 677-678.

Logan formation—Concluded.

	Feet	Inches
Berne member.		
4. Coarse-grained, cross-bedded, yellowish-brown sandstone with a few quartz pebbles along the bedding planes. Upper contact shows irregularities	4	--
3. Conglomerate consisting of quartz pebbles $\frac{1}{16}$ to $\frac{1}{2}$ inch in diameter and an occasional sandstone pebble up to 2 inches in diameter in a coarse yellowish-brown sandstone matrix	--	2 to 6
2. Medium-grained, yellowish-brown sandstone	--	10
Cuyahoga formation.		
Black Hand member.		
1. Grayish-blue shale	2	--

Variation in detail of the Berne member is well shown by comparing the last exposure with that $1\frac{1}{2}$ miles west along the highway in the south central part of Section 16, Jackson Township, Ashland County. At the latter place, as shown in the following section, no distinct conglomerate bed is developed, whereas near Pleasant Home the conglomerate is definite, although less than 6 inches in thickness.

Rocks measured in the south central part of Section 26, Jackson Township, Ashland County

	Feet	Inches
Byer member.		
6. Fine-grained, grayish-brown sandstone	1	8
Berne member.		
5. Coarse-grained, yellowish-brown sandstone	1	2
4. Medium-grained sandstone	2	--
3. Coarse-grained, yellowish-brown sandstone containing a few quartz pebbles of about $\frac{1}{16}$ inch diameter	3	--
2. Medium-grained, yellowish-brown sandstone	1	--
Black Hand member.		
1. Grayish-blue shale	4	--

Of different character from either of these exposures is the one 2 miles south in Section 12, Congress Township, northwest of Lattasburg which has been described on page 58. At the latter place the total thickness of the member is scarcely 18 inches and the two thin, coarse sandstone beds are separated by about one-half inch of shale. These and other exposures in the northwestern part of the township seem to indicate a thinning and a decrease in conglomeratic character in the Berne member to the northwest.

To the south along Lake Fork, just west of the county line, there are a number of good exposures. A description of the Berne member

as developed in Section 34, Mohican Township, Ashland County, has already been given. (See page 58.) About 1 mile southwest of this place in the NE. ¼ SE. ¼ Section 4, Lake Township, Ashland County, in a gully back of a farm house there is an excellent exposure.

Divisions of the Berne member in Section 4, Lake Township, Ashland County

		Feet	Inches
Byer member.			
12.	Fine-grained sandstone	10	--
11.	Gray blue shale	--	6
10.	Fine-grained sandstone	2	8
Berne member.			
9.	Coarse-grained, yellowish sandstone with a few pebbles on certain bedding planes	2	--
8.	Thin-bedded, fine-grained, brown sandstone	--	4
7.	Fine-grained, gray sandstone	--	3
6.	Medium-grained, yellowish-brown sandstone	--	4
5.	Coarse-grained, yellowish-brown sandstone	1	--
4.	Conglomerate consisting of a matrix of coarse sandstone with pebbles to ½ inch in diameter	--	4
3.	Medium-grained sandstone	2	4
2.	Conglomerate consisting of a coarse sandstone matrix with pebbles ranging from $\frac{1}{16}$ to 1 inch in diameter, predominately ¼ inch. Contact with shale beneath undulatory, with irregularities of 2 to 4 inches		2 to 6
Black Hand member.			
1.	Gray blue shale	20	--

In this section the total thickness of the Berne member is not much greater than in the northwestern corner of the county, but the conglomerate bed is very definite and well developed. In this exposure as well as in others along Lake Fork the conglomerate bed lies directly on the Black Hand shale. The base of the Berne member is at that of the lowest conglomerate bed. The upper limit is less definite, but the practice has been to include in the Berne all the associated coarse-grained sandstone, though separated by a slight thickness of fine-grained sandstone from the underlying coarse beds.

Killbuck Valley.—Most of the outcrops of the Berne member are found along Killbuck Valley and its tributaries. Between Section 16, Congress Township, where there is the most northerly outcrop, and Section 27, Franklin Township (T 15 N. R. 13 W.), south of which the beds are under cover, there are many excellent exposures and it is from this region that the character of the Berne member is known.

The tendency of the Berne member to become thinner and less conglomeratic to the north and west, as already indicated for the western part of the county, is well shown along Killbuck Valley.

The most northerly exposure is in Section 16, Congress Township, where the total thickness is less than 3 feet and the conglomeratic character is almost entirely lacking. The coarse beds of the Berne in this section are very similar to those farther west near Pleasant Home and Lattasburg.

Strata measured in SW. ¼ of Section 16, Congress Township

	Feet	Inches
Logan formation.		
Byer member.		
2. Fine-grained, grayish-brown, thin-bedded sandstone	3	--
Berne member.		
1. Coarse-grained, loosely-cemented, yellowish sandstone showing cross bedding. Lower 4 inches contains a few pebbles. Beds have a thickness of 2 to 8 inches. Both upper and lower contacts show undulations	2	6

One of the best exposures of this member is in a ravine in the northeast part of Section 35, Congress Township. Not only is the Berne member well shown, but there is also the greatest thickness in a continuous exposure of the Waverly beds to be found any place in the county—in all about 230 feet, and, if the outcrop on the hilltop above be included, about 280 feet.

Section measured in the ravine northeast from Armstrong in Section 36, Congress Township

	Feet	Inches
Logan formation.		
Vinton member.		
19. Fine-grained, brown sandstone and covered	46	--
18. Fine-grained, grayish-buff sandstone with a slightly greenish cast, with a few shale beds varying in thickness from 2 to 5 inches. Sandstone beds show ripple marks	28	--
Allensville member.		
17. Conglomerate, consisting of a dense medium-grained sandstone with pebbles from $\frac{1}{16}$ to $\frac{1}{2}$ inch in diameter	--	10 to 11
Byer member.		
16. Fine-grained, light greenish-brown sandstone showing ripple marks. Fossiliferous at certain horizons	61	--

Logan formation—Concluded.

	Feet	Inches
Berne member.		
15. Fine-grained, bluish-gray sandstone with coarse sand grains on the bedding planes. Thickness of beds 4 to 6 inches	1	8
14. Coarse-grained, yellow sandstone with a few thin fine-grained layers. Lower contact shows undulations. Coarsest at base. No cross bedding	3	4
13. Coarse-grained, yellow sandstone showing cross bedding. Lower part contains mud balls ¼ to 1 inch in diameter	1	9
12. Medium-grained, dark gray sandstone showing some cross bedding. A few pebbles in lower inch of the sandstone. Base an erosion plane	3	4
11. Conglomerate made up of pebbles ¼ to ½ inch in diameter, with ½ inch predominating, in a coarse-grained sandstone matrix. Very hard and dense and so firmly cemented that the unweathered rock breaks across the quartz pebbles. Base an erosion plane	2	2
10. Dark gray, medium-grained sandstone with an occasional coarse zone in upper portion. Evidence of plant remains	--	4 to 6
9. Dark gray shale	--	6 to 14
8. Conglomerate with quartz pebbles $\frac{1}{16}$ to ½ inch in diameter with coarse sandstone matrix. Shows wave marks, crest to crest is 7 feet, maximum thickness at crest of conglomerate is 12 inches, at trough is 0 to 2 inches	--	0 to 12
Cuyahoga formation.		
Black Hand member.		
7. Fine to coarse, dark gray, micaceous sandstone in thin laminae alternating with gray arenaceous shales	11	--
6. Gray blue shale with a few ironstone concretionary layers in the lower portion. Fossiliferous zone about 20 feet above base of shale	69	--
Armstrong member.		
5. Fine-grained, grayish-brown sandstone with which is associated about 5 per cent of shale	40	--
Burbank member.		
4. Grayish-blue shale	1	10
3. Fine-grained, brown sandstone	2	2
2. Grayish-blue shale	3	--
1. Fine-grained sandstone	2	--

At this place the Berne member is from two to three times as thick as in the western portion of the county. The conglomerate beds are much thicker, but similar in number to those described in the section in Ashland County (page 72). The wave marks are unusual and were not observed at any other place.

A.—View of the Berne member, Sec. 36, Congress Township, showing the conglomerate in two beds separated by sandstone and shale, also the wave marks in lower bed.

B.—View of Logan formation. Reddig's Quarry north of Wooster. The camera case in the center of the picture is resting on the Allensville member, with Byer beds below and Vinton above.

In marked contrast to this exposure is that in Shade Creek Valley about 2 miles northwest for which the section is given on page 61. In Shade Creek Valley the conglomerate beds are almost lacking, being represented by a few pebbles only at two horizons. The beds are largely coarse sandstone which rests directly on the shale.

South of Armstrong in a ravine in the northeast quarter of Section 2, Chester Township, the Berne member has a thickness greater than at any other place on the west side of Killbuck Valley.

Strata measured in NE. ¼ Section 2, Chester Township

Logan formation.	Feet	Inches
Vinton member.		
16. Fine-grained sandstone	2	--
Allensville member.		
15. Conglomerate	1	4
Byer member.		
14. Fine-grained, grayish-buff sandstone	67	--
Berne member.		
13. Coarse-grained, loosely-cemented sandstone	2	2
12. Medium-grained, dark gray sandstone	--	2
11. Coarse-grained, yellow sandstone	--	8
10. Medium-grained, dark gray sandstone	--	6
9. Coarse-grained, yellow, cross-bedded, loosely-cemented sandstone. Lower 6 inches conglomeratic	6	5
8. Medium-grained, dark gray sandstone	6	--
7. Grayish-blue shale	--	6
6. Medium-grained, gray sandstone	1	8
5. Coarse-grained, yellowish sandstone	2	6
4. Medium-grained, gray buff sandstone	--	7
3. Conglomerate with quartz pebbles 1/16 to ¼ inch, predominately 1/16 inch	--	2
2. Medium-grained, bluish-gray sandstone containing a few pebbles	--	3
Cuyahoga Formation.		
Black Hand member.		
1. Grayish-blue shale	3	--

When compared with the preceding section measured east of Armstrong there appears to be little resemblance in the details of the succession of beds in the Berne. Zones 3, 5, and 9 of the former are probably the equivalent of 8, 11, and 13 respectively of the latter. A comparison of the two sections emphasizes the marked variation in details in short distances.

To the south in the upper part of Cedar Valley the Berne member

is thinner, and consists of about 2 feet of coarse sandstone above 1 foot of conglomerate. In Funk's Hollow in Section 23, there is considerable increase in thickness as shown in the section given on page 60. At this place the main conglomerate bed is 1½ feet above the underlying shale, being separated from it by a layer of coarse, slightly pebbly sandstone. Along Little Killbuck Creek exposures show 8 feet of coarse sandstone above 10 inches of conglomerate.

Outcrops on the north side of Rathburn Run in Section 27, Chester Township, show little or no conglomerate, its place being taken by a coarse sandstone which contains a few pebbles, and show marked cross bedding. The total thickness of the coarse beds is approximately the same as in Little Killbuck Valley to the north. In the SW. ¼ SW. ¼ of Section 35, Chester Township, on the south side of the same valley, the conglomerate bed has a thickness of about 10 inches and lies directly on the shales.

A comparison of the sections of the Berne given above with that of the shale pit near Wooster given under the description of the Black Hand member (page 62) shows a marked change in the succession of beds. In most cases in the preceding sections the conglomerate bed rests on or near the shale, whereas in the shale pit it is separated from the shale by a considerable thickness of Black Hand sandstone. Further the coarse beds overlying the conglomerate in the Berne member west of the Killbuck are missing at Wooster and the conglomerate is overlain directly by fine-grained sandstone which has been placed in the Byer member. In fact the Berne member at Wooster is confined to the conglomerate bed, which is the usual condition where it is underlain by the sandstone facies of the Black Hand. This succession consisting of coarse sandstone, overlain by conglomerate and fine sandstone, is found north of Wooster at least as far as Section 29, Wayne Township, although in the ravine northeast of Armstrong, already mentioned, coarse sandstone overlies the conglomerate beds, even though sandstone is slightly developed in the upper part of the Black Hand. East of Wooster the conglomerate bed lies immediately underneath the fine-grained Byer sandstone.

The interval between the Berne member and the Berea sandstone at a number of places near Killbuck Valley is shown in the following table. Logs of gas or oil wells near exposures of the Berne furnished the data for determining the elevation of the Berea.

Interval between the Berne member and Berea sandstone

	Elevation above sea level		
	Berea sandstone	Berne member	Interval
Location	Feet	Feet	Feet
Sec. 25, Congress Township	440	1,064	624
Sec. 31, Canaan Township	466	1,050	584
Sec. 7, Wooster Township	369	944	575

East of Wooster in valleys tributary to the Killbuck there are a number of exposures. The outcrop in a ravine along Little Apple Creek in SE. ¼ NE. ¼ Section 34, Wayne Township, is representative of this region:

Strata in a ravine along Little Apple Creek in Section 34, Wayne Township

Logan Formation.

Byer member.
4. Fine-grained sandstone.

Berne member.	Feet	Inches
3. Conglomerate made up largely of quartz pebbles ¼ to ½ inch in diameter, ½ inch predominating. Upper surface shows undulation of ½ to 1 inch		9 to 14

Cuyahoga Formation.

Black Hand member.		
2. Medium to coarse-grained sandstone	2	11
1. Coarse-grained, yellowish, massive sandstone, rather loosely cemented, especially in lower 3 feet	13	1

That this conglomerate is the Berne member was confirmed by locating the Allensville farther up the ravine. This exposure is similar to that at Coe's quarry in Section 2, Wooster Township, for which the section has been given on page 63.

Exposures east of Killbuck Valley.—Farther east the conglomerate outcrops along Little Chippewa Valley. It is exposed along the road on the west side of Section 24, Green Township, a short distance northwest of Orrville. However, only a conglomeratic layer underlain by a slight thickness of coarse sandstone was exposed, so the outcrop was rather indefinite.

The best exposures of the Berne member in Little Chippewa Valley are in Section 33, Milton Township, and a section measured at this place is recorded on page 64. Here the coarse beds in the upper part of the Black Hand member have considerable thickness. The overlying conglomerate has a thickness in places of almost 2 feet, and in part the matrix is made up of extremely coarse sand. Part of the conglomerate is very fossiliferous, and the presence of genus *Schizodus* shows it to be marine. The fauna is distinctly Mississippian.

Northeast of Little Chippewa Valley the Berne member was not positively identified. The coarse-grained sandstone of the upper part of the Black Hand outcrops at a number of places north of Chippewa Creek and at a few places conglomeratic slabs were found in close association with the coarse-grained sandstone in the bed of ravines, but not in place.

Fossils.—The Berne member contains everywhere fossils of marine organisms. However, in many instances it is difficult to identify the forms, because they are commonly not well preserved and also because of the nature of the impression on the very coarse-grained rock. In the SE. ¼ SW. ¼ Section 33, Milton Township, a bed of very fossiliferous conglomerate yielded the following forms:

Segments of crinoid stems.
Edmondia sulcifera Herrick.
Schizodus cuneus Hall.
Schizodus prolongatus Herrick.
Schizodus triangularis Herrick.

The genus *Schizodus* is especially well represented both as to species and also as to number of individuals.

Byer Member

The Byer member consists of a succession of fine-grained sandstones with a few thin shale beds. At the outcrop where exposed to weathering the sandstone has a buff color, whereas the unweathered rock has a slightly greenish-gray tinge. The thickness of the Byer varies from 50 to 80 feet, the smaller figure holding near Wooster with a thickening to the north and west. The extreme uniformity in lithology of this member, and also of the remainder of the Logan, both laterally and vertically, is one of the outstanding characteristics, and is especially striking when compared with the underlying Cuyahoga formation. The fine-grained sandstones of the Byer and also of the overlying Vinton member, which is quite similar, form the surface rocks on the upland over a large part of the county which is underlain by the Mississippian formations.

The name Byer is taken from Hyde's classification for central Ohio.[1] "The member is named from the town of Byer in the northern part of Jackson County where it is well shown in the railroad cuts east of the village." The member includes the strata between Conglomerate I and Conglomerate II of Cooper and called by him Bed No. II.[2]

In the western part of the county there are no exposures showing the complete thickness of the Byer member. In the section already given (page 58) for a ravine just west of the county line in Ashland County, the fine-grained sandstone above the Berne member belongs to the Byer. More shale is associated with the sandstones than is usual along Killbuck Valley. The total thickness of the Byer member was not determined, as the Allensville which marks the upper limit

[1]Hyde, J. E., Jour. Geol., Vol. 23, 1915, p. 773.
[2]Cooper, W. F., The Waverly Group, Denison University Bull. No. 5, 1889-90, p. 28.

could not be located. In the ravine in the northwest quarter of Section 36, Plain Township (T. 21 N. R. 15 W.), the Byer is well exposed. The Berne member outcrops near the county line; above this exposure the valley is cut in drift for about a quarter of a mile and then in typical fine-grained Logan sandstone. The Allensville member is not exposed in this ravine.

In the central part of the county along Killbuck Valley the Byer member outcrops at many places. The entire thickness is exposed in the ravine east of Armstrong (page 73), where the total is about 61 feet and is made up almost entirely of uniformly textured fine-grained sandstone in beds varying from 2 to 14 inches. Numerous beds show fossil impressions. Ripple marks with a direction of N. 35° W. and an average width crest to crest of about 3½ inches were also noted.

The Byer member has a thickness of 67 feet in Section 2, Chester Township, and is similar to the exposure near Armstrong. In Funk's Hollow (Section 23, Chester) the full thickness is not exposed in one ravine, but a combined section gave a total thickness of 57 feet. The greatest thickness observed for the Byer member was in SE. ¼ Section 27, Chester Township, along the north valley wall of Little Killbuck Creek, where the interval between the Berne member and the base of the Allensville is 78 feet. The entire thickness is not exposed at this place but wherever seen consists of characteristic fine-grained sandstone.

The Byer member is exposed in the southwest corner of Section 35, Chester Township, in a ravine on the south side of Rathburn Run. In this exposure the shale bed near the middle of the member is of unusual thickness for this part of the county, as it here seldom exceeds 2 to 4 inches in thickness, whereas in many exposures to the north along Killbuck Valley shale is almost entirely lacking. The succession of strata at this exposure is shown below:

Section in ravine SW. ¼ Section 35, Chester Township, on the south side of Rathburn Run

Logan Formation.	Feet	Inches
Vinton member.		
10. Fine-grained, buff sandstone	3	--
Allensville member.		
9. Conglomerate with pebbles ranging from ¼ to 2 inches, predominately ½ inch	1	--
Byer member.		
8. Fine-grained sandstone in beds of 2 to 12 inches	35	--
7. Gray blue shale	--	8
6. Fine-grained sandstone	40	4

Logan formation—Concluded.		
Berne member.	Feet	Inches
5. Coarse-grained, yellowish-brown sandstone	--	6
4. Medium-grained, gray sandstone	--	6
3. Coarse-grained, yellow sandstone containing a few pebbles about ⅛ inch in diameter	6	7
2. Conglomerate with quartz pebbles 1/16 to ¼ inch in diameter, predominately ¼ inch, and shale pebbles up to 2 inches	--	10
Cuyahoga Formation.		
Black Hand member.		
1. Gray blue shale	5	--

East of Killbuck Valley in the vicinity of Wooster there are numerous exposures of the Byer member in Clear Creek, Little Apple Creek, and Apple Creek valleys. In these exposures the only break in the succession of fine-grained sandstone is made by a few thin shale beds. In Section 29, Wayne Township, the thickness is between 53 and 55 feet, whereas in the ravine in which Reddig's quarry is located it appears to be between 45 and 50 feet, although the exact position of the base could not be determined.

East of the divide which separates the Killbuck drainage basin from the streams to the east, there are many exposures of fine-grained sandstones which occur at such an elevation as to be in all probability above the horizon of the Berne member and show the uniform characteristics of the fine-grained Logan sandstones. In the northeastern part of the county such strata are undoubtedly Byer sandstone, but farther south they may in part belong to the overlying Vinton member. Fine-grained sandstone is exposed at the top of the hill in the southern part of Section 16, Chippewa Township, where a cut has been made for the highway. The following section was measured at this place:

Byer member.	Feet
2. Fine-grained, grayish-yellow sandstone	3
1. Yellowish-brown shale	8

Because of the location at a distance from other Waverly strata, there may be some question as to their exact horizon but none as to their being Mississippian. This exposure is the farthest northeast of any known Waverly in the county. Less than 2 miles east the Sharon Conglomerate, basal member of the Pennsylvanian, outcrops at a lower level.

Fossils.—At a number of horizons in the Byer member fossils are present in considerable number. The strata just above the base are exposed near the lower end of the ravine west from Reddig's quarry a short distance north of Wooster. The fossils in this sandstone are the following:

Segments of crinoid stems.
Crenipecten winchelli (Meek).
Schizodus cuneus Hall.

A fossiliferous horizon about 30 feet below the Allensville member outcrops in a ravine in NW. ¼ Section 35, Plain Township. The following were identified in a collection made at this place:

Segments of crinoid stems.
Productus arcuatus Hall.
Syringothyris textus (Hall).
Crenipecten winchelli (Meek).
Schizodus triangularis Herrick.

In Coe's quarry in the northern part of Section 2, Wooster Township, the beds above and below the Berne member, including the lower portion of the Byer, are exposed. In the refuse pile the following fossils were collected:

Crinoid segments.
Chonetes pulchellus Winchell.
Allerisma convexa Herrick.
Crenipecten winchelli (Meek).
Palaeoneilo concentrica var. Herrick.
Schizodus sp.
Platyceras sp.

Allensville Member

The Allensville is a marine conglomerate which varies in thickness from 8 to 24 inches. Although of slight thickness, its persistence over a large area makes it of equal value with the Berne member as a horizon marker, in fact, were it not for this conglomerate there would be little basis for dividing the beds above the Berne horizon, as it forms the only marked break in a long succession of fine-grained sandstones and shales. The Allensville occurs 50 to 80 feet above the Berne member, and 650 to 700 feet above the Berea sandstone. It consists of a rather firmly cemented matrix of medium to coarse-grained sandstone with quartz pebbles ranging from one-eighth to one-half inch in diameter. The contact with the underlying Byer member is a disconformity.

Following Hyde's classification[1] for central and southern Ohio, the conglomerate bed is called the Allensville member, the name having been selected by him from a small village in the western part of Vinton County.

Read recognized this horizon in his report on the geology of Wayne County.[2] In a discussion of the Waverly, mention is made by him of

[1]Hyde, J. E., Jour. Geol., Vol. 23, 1915, p. 775.
[2]Read, M. C., Geol. Surv. of Ohio, Vol. 3, 1878, p. 526.

a coarse pebble bed in Reddig's quarry. Cooper[1] called these coarse beds "Conglomerate II" in certain sections measured by him in the county and suggested a probable correlation with the "Conglomerate II" of Herrick in central Ohio.

Lamb[2] has described these beds, which he called the "Upper Conglomerate," as follows: "It is a remarkably uniform stratum in thickness, in composition, and in uniformity of pebbles. From east to west it has been observed across nearly its entire belt of outcrop, and about 25 miles along the belt. It is only 1 to 3 feet in thickness, is always largely, and often purely a bed of quartz pebbles ranging in size from shot to pebbles three-fourths inch in diameter and notably even in size at any one point. Cobblestones from the underlying rock 3 to 5 inches in diameter are found in places."

One of the best known exposures of the Allensville member is in Reddig's quarry at the head of Christmas Run in SW. ¼ SE. ¼ Section 33, Wayne Township. The lithological character, thickness, and relation to the beds above and below so well shown in this exposure can be duplicated in nearly every outcrop of the Allensville. The section measured at Reddig's quarry is as follows:

Section measured in Reddig's Quarry north of Wooster

Logan Formation.	Feet	Inches
Vinton member.		
9. Fine-grained, buff, thin-bedded sandstone. Beds 2 to 3 inches	5	--
8. Fossiliferous zone in sandstone, persistent	--	6
7. Fine-grained sandstone, not so massive as that below conglomerate	7	6
6. Fossiliferous zone in sandstone, irregular, with thin shale lenses in places	--	1 to 4
5. Sandstone, in one bed	1	--
4. Fossiliferous zone in sandstone	--	3
3. Sandstone, slightly coarser than that underneath conglomerate. Thickness 9 to 16 inches. Average thickness	1	--
Allensville member.		
2. Conglomerate, fossiliferous, pebbles largely quartz varying in size from ¼ to ½ inch. Both upper and lower surface undulatory overlying sandstone cutting down into conglomerate bed for 3 to 5 inches in places, showing a disconformity. Thin irregular lens of shale ¼ to ½ inch at base in places. Thickness 8 to 15 inches. Average	--	11

[1]Cooper, W. F., Bull. Denison Univ., No. 5, 1888-90, p. 28.

[2]Lamb, G. F., Middle Mississippian Unconformities and Conglomerates in Northern Ohio, Ohio Naturalist, Vol. 14, 1914, p. 346.

Logan formation—Concluded.

Byer member.	Feet	Inches
1. Fine-grained, grayish-brown, massive sandstone, beds 1 foot to 1 foot 6 inches thick, irregularly fractured	14	--

The northernmost exposure of the Allensville is in Section 36, Congress Township (page 73), where the total thickness is 10 to 11 inches and consists of a conglomerate with a dense medium-grained sandstone matrix containing pebbles varying from one-sixteenth to one-eighth of an inch in diameter

To the south of Wooster the Allensville member can be traced to within less than a mile of the southern county line. In Section 19, Franklin Township, in the ravine east of the Hazeldell School, the conglomerate bed is typically developed.

Section measured southeast of Hazeldell School in the central part of Section 19, Franklin Township

Logan Formation.

Vinton member.	Feet	Inches
5. Fine-grained sandstone in beds of 4 to 10 inches with an occasional thin shale lens	10	--
4. Fine-grained, thin-bedded sandstone in beds of ½ to 2 inches with thin shale partings	2	--
3. Gray blue shale which thins where underlying conglomerate thickens	--	2 to 6
Allensville member.		
2. Conglomerate, with quartz pebbles up to ⅜ inch in diameter, largely between ¼ and ½ inch, and some fine-grained sandstone cobbles as large as 2 inches in diameter. Lower and upper surface undulatory, showing a disconformity. Thickness 6 to 16 inches. Average	--	11
Byer member.		
1. Fine-grained, buff, massive sandstone slightly coarser than average. Bed up to 24 inches in thickness	14	--

As exposed here close to the southern county line there is no marked difference from the most northerly outcrop, located 5 miles south of Burbank. The difference in elevation of the base of the bed at the two places is about 214 feet, which for a distance of 16½ miles gives a dip of slightly more than 12 feet to the mile. The change in elevation to an exposure in Section 12, Plain Township, is 128 feet and the distance is 9 miles which gives a dip of about 14 feet to the mile. Lamb[1] reports the dip as 13 feet per mile in the portion of Killbuck Valley studied by him. As both the southern localities are very close to oil and gas

[1]Lamb, G. F., Ohio Naturalist, Vol. 14, 1914, p. 346.

territory, it is probable that some structural feature may influence the elevation of the beds at those localities, and hence modify the result calculated from the elevations.

By far the majority of the exposures of the Allensville member show a thickness between 8 and 14 inches. North of Wooster the greatest thickness of distinctly conglomeratic strata is in a ravine in the southeastern part of Section 36, Congress Township, where it has thickened to 20 inches. Less than a mile to the south the conglomerate has thinned to 8 inches.

In a few places sandstone, slightly coarser than the typical fine-grained rock of the major portion of the Logan, overlies the conglomerate a few inches. Such is the case in the north part of Section 36, Congress Township, also in Section 28, Chester. At the latter place a distinct bed of medium-grained sandstone 8 inches in thickness overlies 15 inches of conglomerate.

The most easterly exposure of the Allensville member is in a ravine northeast of Honeytown in Section 6, East Union Township, where the bed is exposed in an old quarry. The thickness varies from 10 to 14 inches, and the pebbles which make up the bed range from one-sixteenth to 1 inch in diameter, although a large proportion are about one-eighth inch. In places in the upper part of the bed the coarse sandstone is nearly devoid of pebbles. The associated beds above and below are fine-grained sandstone characteristic of the Logan. The contact with the Byer beneath shows undulations which indicate a disconformity.

Exposures of the Allensville west of Honeytown along the Lincoln Highway occur along the roadside at two places at an elevation slightly greater than 1,000 feet above sea level. The member also is exposed in the old quarry on the Ohio Agricultural Experiment Station Farm in the NE. ¼ Section 15, Wooster Township. The conglomeratic bed outcrops also in the embankment along the highway a short distance south of the west entrance to the Station grounds.

The most southerly exposure of the Allensville on the east side of Killbuck Valley is in the northwest part of Section 34, Franklin Township.

Strata measured in NW. ¼ Section 34, Franklin Township

	Feet	Inches
Logan Formation.		
Vinton member.		
6. Fine-grained, grayish-brown sandstone	2	--
5. Gray blue shale, slightly gritty	1	4
4. Fine-grained sandstone	3	--
3. Grayish-blue shale. Thickness 6 to 12 inches. Average	--	9

Logan formation—Concluded.

Allensville member.	Feet	Inches
2. Conglomerate, consisting of a medium to coarse sandstone matrix with quarts pebbles up to 1 inch and sandstone cobbles 2 to 3 inches in diameter. Upper 4 to 6 inches almost entirely pebbles ranging from ¼ to ½ inch diameter. Both upper and lower surface show undulations. Thickness 14 to 24 inches. Average	1	7
Byer member.		
1. Fine-grained sandstone	32	--

Here as elsewhere the undulatory nature of the contacts both above and below is very marked. The conglomerate is resting on fine-grained sandstone. The shale above thickens and thins with changes in the surface of the conglomerate, whereas the upper surface of the shale is conformable with the sandstone above.

The elevation of the conglomerate at this place is about 908 feet above sea level, whereas less than a mile north a conglomerate underlain by coarse sandstone and considered to be the Berne member has an elevation of approximately 898 feet. The Allensville member near the Hazeldell School already mentioned, which occurs about 5½ miles south and 2½ miles west, has an elevation of 925 feet. No outcrops of the conglomerate could be located in the intervening area as most of the slopes have a heavy covering of drift. The significance of these elevations is not clear. Either the Allensville member has dropped over 50 feet in less than a mile or the identification is incorrect. The extension of the Wooster oil field to the southwest terminates in Section 34, so the change in elevation of the surface strata may be connected with the change in rock structure which has made conditions unfavorable for the accumulation of oil and gas.

The relation of the Allensville member to the Berea sandstone can be determined by comparing the elevation of the Berea given in the logs of oil or gas wells with the elevation of the Allensville. The following table shows the elevation of these horizons at a number of places, also the interval between them.

Interval between Allensville member and Berea sandstone

Location	Elevation above sea level of top of Berea sandstone	Elevation above sea level of base of Allensville member	Interval
	Feet	Feet	Feet
Sec. 25, Congress Township	440	1,139	699
Sec. 31, Canaan Township	466	1,128	662
Sec. 27, Chester Township	439	1,092	653

The range in interval is between 650 and 700 feet. Data for other

places gave a variation from 613 to 721 feet, although in some instances the oil or gas well, for which the record was used, is located some distance from the exposure of the Allensville, and this in an oil and gas region might introduce a considerable error. Although it is recognized that this data is subject to such a possibility, still it shows in a general way the stratigraphic position of the Allensville with reference to the Berea sandstone.

West of Killbuck Valley outcrops of the Allensville beds are very few in number. In the north part of Section 35, Plain Township, in a cut along the roadside the thickness is 14 inches. About 2 miles west in the north central part of Section 33, it outcrops a short distance north of the fork on the north and south road.

West of Muddy Fork Valley in Plain Township, the Allensville member has not been located. In several ravines near Lake Fork just west of the county line no conglomerate bed is to be found at the proper interval above the Berne member. Whether or not the Allensville has passed into sandstone or shale to the west cannot be said. The evidence is not conclusive.

The Allensville member, though thin, can be traced almost across the county north and south. If, as is thought, it can be correlated with similar beds in central Ohio which extend to the Ohio River, its persistence is remarkable.

The Vinton Member

The Vinton is the youngest member of the Waverly series in Ohio, and is the highest Mississippian division occurring in Wayne County. The Vinton consists of fine-grained sandstone and a small percentage of shale, and resembles in many respects the Byer member, although the proportion of shale to sandstone is greater than is typical of the Byer. It contains numerous fossiliferous zones. The name Vinton was applied to the member by Hyde from exposures in Vinton County.[1]

The Vinton forms the surface strata for a large part of the upland in the central and western parts of the county. In the eastern part, exposures on the upland of fine-grained sandstone may belong to Vinton, although the Byer sandstone is quite similar and cannot be easily differentiated where the relation to the Allensville is not known.

The maximum thickness of the member is probably over 200 feet. The greatest thickness in one section is in a ravine in sections 34 and 35, Franklin Township, where the interval between the Allensville member and the highest outcrop is 180 feet. Farther south higher horizons are exposed, but the relation to the underlying Allensville cannot be determined, since the latter is below drainage. What the total thickness of the Vinton may have been at one time is not known,

[1]Hyde, J. E., Jour. Geol., Vol. 23, 1915, p. 778.

for the upper limit at all places, where the member has not been removed entirely, is a surface of erosion. Where the Pennsylvanian strata rest on the Waverly they are underlain in places by 100 feet or more of the Vinton beds, elsewhere the Pennsylvanian may rest on the Cuyahoga.

Wherever exposed north of Wooster, the Vinton member consists of fine-grained sandstones with a few layers of shale varying in thickness from 2 to 5 inches. In the ravine east of Armstrong about 28 feet of fine-grained sandstone is shown. (See page 73.) On the upland near-by the Vinton member is exposed 46 feet above the highest outcrop in the ravine, which with that in the ravine gives a total thickness for the member of 74 feet. Near Wooster only the lower part of the Vinton is exposed. In Reddig's quarry (page 82) it develops into very thin beds within a few feet above the Allensville conglomerate. In Section 28, Wayne Township, where a Pennsylvanian outlier rests on the Vinton strata the total thickness of the latter is not more than 80 feet.

The Vinton member outcrops in the southern part of the county along Salt Creek Valley near Fredericksburg. East of the village this stream is flowing over sandstone, where on the precipitous slopes a considerable thickness of Vinton beds is exposed. The proportion of shale to sandstone is greater than is characteristic of the member north of Wooster. Mud ball layers similar to those in zones 4 and 10 were not observed farther north in the county, although they may be seen south of the county line along Salt Creek Valley.

Strata measured in ravine east of Fredericksburg in NW. ¼ Section 20, Salt Creek Township

Logan Formation.

	Vinton member.	Feet	Inches
12.	Fine-grained sandstone and sandy shale alternating in 2 to 4 inch beds	3	--
11.	Fine-grained, buff sandstone in beds of 2 to 6 inches	8	--
10.	Gray shale, with layer containing brown mud balls (diameter ½ to ¾ inch) about 2 inches from top of shale. Thickness of layer 2 to 4 inches	5	4
9.	Fine-grained sandstone, irregularly bedded, badly fractured, beds 10 to 36 inches thick, showing some cross bedding	20	10
8.	Fine-grained, thin-bedded sandstone with small amount of shale	2	6
7.	Gray shale	2	8
6.	Fine-grained, shaly sandstone	2	2
5.	Fine-grained sandstone	1	--
4.	Fine-grained sandstone containing rounded sandstone balls ½ to 2 inches in diameter	--	6 to 8
3.	Fine-grained, buff, heavy-bedded sandstone	4	6
2.	Bluish-gray shale containing a few sandstone layers	3	6
1.	Fine-grained, irregularly bedded sandstone. Stream bed	1	--

On the hilltop above this, the Logan sandstone is exposed along the roadside near the cemetery. The total thickness of the exposure, including the outcrop above the stream and the interval to the hilltop, is more than 100 feet. The base of the member is everywhere below drainage in this part of the county, hence the total thickness of the Vinton could not be determined.

West of Killbuck Valley the Vinton strata present no features which differ from those already described for the vicinity of Wooster. Exposures of fine-grained sandstone, which are numerous in road cuts on the upland, have much the same appearance everywhere. The failure to find the Allensville member in exposures south of Funk near the west county line makes the separation of the Vinton from the Byer difficult. The thickness of the strata above the Berne member is sufficient to make it evident that much of the rock outcropping on the upland belongs to the Vinton.

East of the Killbuck drainage basin the Allensville member which is the key rock for separating the Vinton and Byer is not exposed. Probably much of the fine-grained sandstone outcropping in the upper part of ravines and on the upland in this part of the county belongs to the Byer member, much or all of the Vinton having been removed by erosion.

The uniformity of the Vinton member and its similarity to the Byer stand out as characteristic features of the Logan formation. The contrast with the Cuyahoga formation, with its variation in lithology, both laterally and vertically, is very marked.

Fossils.—Fossil horizons are numerous in the Vinton member. A collection made from a zone about 10 feet above the Allensville in Reddig's quarry north of Wooster contained the following forms:

Segments of crinoid stems.
Camarotaechia sageriana (Winchell).
Productus sp.
Palaeoneilo concentrica var. Herrick.

MAXVILLE LIMESTONE

The Maxville limestone, which overlies the Logan formation in parts of central and southern Ohio, is not found in Wayne County; if it were ever present it has been removed by erosion. The only evidence of its former development in this part of the State is based on the presence of fossiliferous cherty pebbles and cobbles in the Sharon conglomerate, the basal member of the Pennsylvanian. Morse[1] has indicated the occurrence of such fossiliferous blocks in the conglomerate in Licking County, and in the Cuyahoga Gorge and at Boston Ledges in Summit County.

[1]Morse, William Clifford, The Maxville Limestone, Geol. Surv. Ohio, Fourth Series, Bull. 13, 1910, p. 99.

In Wayne County such cherty fossiliferous pebbles occur in the conglomerate near Stringtown in Section 18, Franklin Township, also in SW. ¼ Section 11, Plain. The cobbles consist of gray to yellowish-gray chert varying from one-fourth inch to 6 inches in diameter, are subangular to rounded, but seldom show sharp corners. Their composition is largely siliceous; if any calcareous material was ever present it has been entirely removed.

In order to determine whether the fossils which occur in the cobbles show any relation to the Maxville limestone, a collection was made at the exposure about one-fourth mile south of Stringtown. The following forms were identified by Miss Helen Morningstar:

Crinoid segments.
Cystodictya simulans Ulrich.
Fenestella serratula Ulrich.
Fenestella sp.
Rhombopora armata Ulrich.
Delthyris similis Weller.
Productus cestriensis Worthen.

Of this list Nos. 3, 5, and 7 have been identified in the fauna of the Maxville,[1] whereas Nos. 2 and 6 have been observed in the upper Waverly.

It is evident from this fauna that the cobbles are not Pennsylvanian, but rather Mississippian. How far they may have been carried before reaching their present position is problematic; however, the evidence indicates that they have been derived from the Maxville limestone.

[1]Morse, William Clifford, The Fauna of the Maxville Limestone, Proc. Ohio Acad. Sci., Vol. 7, Pt. 7, Sp. Paper No. 17, 1911, pp. 364, 366, 372.

CHAPTER V

THE PENNSYLVANIAN SYSTEM

The Pennsylvanian system of eastern United States is made up of sandstone, shale, and limestone with which are associated beds of clay, iron ore, and coal. The surface rocks of most of eastern Ohio belong to this system, and in the State four major subdivisions are recognized and commonly called formations. These are from the base upward the Pottsville, Allegheny, Conemaugh, and Monongahela.

In Wayne County only the two lower formations are represented—the Pottsville and Allegheny. These outcrop in the eastern and southern parts of the county over an area of 126 square miles out of a total area of 557, a little less than one-fourth of the county. They are extensively developed in Chippewa, Baughman, Sugar Creek, Paint, Salt Creek, and Franklin townships and over limited areas in Milton, East Union, Wayne, Clinton, and Plain townships.

POTTSVILLE FORMATION

The Pottsville formation is by far the most important division of the Pennsylvanian in the county, as the overlying Allegheny is relatively limited in distribution. The Pottsville includes all the rocks from the top of the Mississippian to the base of the Brookville or No. 4 coal, a horizon plane which is largely arbitrary in Ohio, as there is no lithological or faunal basis for making a division at this place. The Pottsville has its greatest thickness in the eastern and northeastern parts of the county where it exceeds 275 feet. In the south-central part the thickness is less than 100 feet.

The contact of the Pennsylvanian and Mississippian systems shows a marked disconformity, which represents extensive erosion. At places this disconformity is not very marked, and, in fact, it may be difficult to locate the contact exactly, but at a few places the disconformity is pronounced. It is well shown at an outcrop located a short distance southeast of Stringtown in Franklin Township, where coarse sandstone and conglomerate of the Pottsville formation rest on fine-grained Logan sandstone. The base of the Pottsville is not horizontal, but rather rests on successive Logan beds. The disconformity is also shown in a ravine in the eastern part of Section 3, Franklin Township, where a depression cut into the Logan sandstone is filled with Pottsville shale within which there is a thin coal bed. A third example exists near the center of Section 21, Sugar Creek Township, where, in a ravine a short distance north of the highway, the uneven Mississippian-Pennsylvanian contact is shown in an isolated rock mass which is surrounded on all sides by drift. At this place Pennsylvanian beds were deposited

against an almost vertical face of Logan sandstone, and for some feet from the contact the Pennsylvanian strata are inclined at an angle of 20 to 25 degrees. This is illustrated in Plate VII B.

The best example of a disconformity in the county is in the railroad cut one-half mile northeast of Marshallville in Chippewa Township. The cut shows two sandstone masses separated by shale, which lies in a depression on the eroded sandstone surface. The nature of the sandstone beds and also the disconformity are shown in Plate VIII.

Such exposures of the contact of the Mississippian and Pennsylvanian systems as those just given are few in number. More commonly there is apparent conformity, and it is only when the elevations of the contact over large areas are determined that an appreciation of the irregularities of the Mississippian surface can be obtained. This is well shown in Sugar Creek Township where in the NW. ¼ Section 28 the contact is between 1,060 and 1,080 feet above sea level, whereas 3 miles east the lowest coal of the Pennsylvanian is at an elevation of less than 950 feet. Another instructive example exists near Fredericksburg. One mile west of the village the contact is at about 1,060 feet, whereas 5½ miles southwest the conglomerate at the base of the Pennsylvanian rests on the Waverly surface at an elevation of 880 feet above sea level. Many other striking illustrations of the magnitude of this disconformity could be given.

The oldest members of the Pennsylvanian system exist in basins and channels on the Waverly surface. The beds resting on the more elevated portions of the Waverly are higher stratigraphically than those in the basins, hence the oldest members of the Pennsylvanian system are not coextensive in distribution with the Pottsville formation.

A generalized section of the Pottsville formation in Wayne County is given below:

Pottsville Formation.		Feet	Inches
17.	Clay, siliceous	4	--
16.	Sandstone and shale	30	--
15.	Coal, *Tionesta or No. 3b* (often wanting)	1	--
14.	Clay	3	--
13.	Sandstone and shale	15	--
12.	Limestone, dark blue, flinty, *Upper Mercer*	2	6
11.	Coal, variable, *Bedford*	1	--
10.	Clay, siliceous	6	--
9.	Sandstone and shale	20	--
8.	Limestone, blue, hard, *Lower Mercer*	2	--
7.	Coal, variable, *Middle Mercer*	1	--
6.	Sandstone and shale	80	--
5.	Coal, *Quakertown or No. 2*	1	--
4.	Clay	5	--
3.	Sandstone and shale	55	--
2.	Coal, *Sharon or No. 1*	5	--
1.	Conglomerate, *Sharon*	50	--
	Total thickness	281	6

A.—View of the disconformity at the base of the Pennsylvanian System. Exposure near Stringtown. Sharon conglomerate resting on the eroded surface of Logan sandstone.

B.—The disconformity at the base of the Pennsylvanian System. View of exposure in Sec. 21, Sugar Creek Township. Pennsylvanian strata resting on the eroded and truncated Waverly surface.

Sharon Conglomerate

The lowest division of the Pottsville is the Sharon conglomerate. Its greatest development in Wayne County is in the northeastern part especially along Chippewa Creek in the southern part of Chippewa Township. Apparently it was laid down in basins or valleys on the Mississippian surface and is either very thin or lacking over the higher parts. Although called a conglomerate, in Wayne County the Sharon is in reality a coarse pebbly sandstone, differing in this respect from its development to the northeast where in many places it is very pebbly.

The character of the Sharon conglomerate is well shown by the following section taken in an old quarry in the NW. ¼ Section 25, Chippewa Township:

Pottsville Formation.	Feet	Inches
5. Coarse, grayish-yellow sandstone	30	--
4. Coal, *Sharon or No. 1*	2	4
3. Clay, gray	1	--
2. Interval, covered	51	--
1. Coarse-grained conglomeratic sandstone, *Sharon conglomerate*	43	--

The Sharon coal outcrops north of the highway above the quarry. The covered interval is probably largely sandstone.

On the south side of the valley, almost directly opposite this old quarry, the Sharon conglomerate is well exposed in two quarries where the stone is removed and crushed for molding sand. In the quarry of the Franklin Industrial Company in Section 25, Chippewa Township, the following section was measured:

Pottsville formation. Sharon conglomerate.	Feet	Inches
2. Sandstone, coarse, yellowish-gray in beds about 1 foot thick, separated in places by thin gray shale layers containing plant remains. Contact with beds below shows a disconformity	16	--
1. Sandstone, coarse-grained with a few conglomeratic layers. Numerous thin pebble bands. Pebbles vary from ⅛ to ½ inch in diameter, largely quarts. Beds massive, at one place 25 feet of sandstone without a parting apparent. Jointing irregular, often fracturing along conglomeratic layers on blasting. Color varies from gray to yellow and red	40	--

In addition to 50 or 60 feet of Sharon exposed in the quarry, test drilling has shown 25 feet of coarse sandstone below its base making a total thickness of at least 75 feet, all of which belongs to the Sharon.

All known exposures of the Sharon in the eastern part of the county are in the Chippewa Valley. To the south the overlying Sharon coal is for the most part under drainage, and where it is above, the elevation is such that the underlying beds are not exposed. Although the conglomerate is probably present under the coal, this has not been confirmed at all places, because drilling usually ceases when the coal horizon is penetrated.

Where the Pottsville rests on the more elevated portions of the Mississippian surface, there are in places beds of coarse sandstone just above the contact which resemble the Sharon. Read[1] has referred these sandstones to the Sharon, but it seems probable that they, in part at least, were deposited later. In some places the Sharon or No. 1 coal at a distance of 2 or 3 miles lies 100 feet below these beds.

In the southwestern portion of the county the basal beds of the Pennsylvanian consist of conglomerate and coarse-grained sandstone, which probably belong to the Sharon, having been laid down in valleys on the Mississippian surface. The best exposures of these beds are near Stringtown in SW. ¼ Section 18, Franklin Township, where the following section was measured along the highway:

	Feet	Inches
Pottsville formation.		
8. Shale, gray brown	12	--
7. Dark clay shale	1	--
6. Coal blossom	1	2
5. Clay, dark	1	--
4. Shale, brown	5	--
3. Covered	15	3
2. Conglomerate, made up of coarse sandstone with quartz pebbles. Many cherty cobbles of 2 to 6 inches diameter (Maxville) in lower foot, disconformity at base, *Sharon conglomerate*	7	3
Logan formation.		
1. Fine-grained sandstone	20	--

This section shows that the total thickness in the southwestern portion of the county even including most of the covered zone (No. 3) is much less than along Chippewa Valley where there is 75 feet at least of these coarse sandstone beds. The presence of Maxville cobbles in the conglomerate is of importance, in that the possibility of the former existence of the Maxville limestone is suggested, as has been pointed out under the discussion of the Mississippian formations (page 88). Another outcrop of a conglomerate containing characteristic Maxville cobbles exists about 6 miles north of Stringtown in the northwestern part of Section 13, Plain Township.

[1]Read, M. C., Geol. Surv. of Ohio, Vol. 3, 1878, p. 538.

A.—View of railroad cut near Marshallville showing the disconformity between the Mississippian and Pennsylvanian Systems.

B.—View showing the horizontal beds exposed in A.

Sharon or No. 1 Coal

Resting on the Sharon conglomerate is a gray fire clay, 2 to 3 feet thick, and this is overlain by a coal bed 3 to 7 feet thick and averaging about 5 feet. This, the Sharon or No. 1 coal, has its greatest development in Chippewa, Baughman, and Salt Creek townships, although it has been mined to some extent in each of the four eastern ones. This area is included in the Massillon coal field which is one of the two important fields of Sharon in the State.

The form of the coal beds was described by Orton in his discussion of the Massillon Coal Field as follows:[1] "As in the case with the Sharon coal seam elsewhere in Ohio, the coal of the Massillon field is in all cases disposed in distinct basins or troughs which range in size from a few acres up to a few hundred, but rarely exceeding two hundred acres; the greater number range between thirty and seventy acres. Each basin or trough holds a lenticular body of coal, the thickest part of which is generally at the center or along the axis of the basin, and which is known among the miners as the 'swamp' of the seam. Toward the margins of the basins the coal grows thin, sometimes gradually, and sometimes by rapid reduction in volume. As the seam is seldom followed by the miner when it runs below two feet in thickness, it is quite possible that some of the basins that appear to be distinct may in reality be connected through a thin sheet of coal that stretches over the hills of the mines. These basins are frequently grouped in close proximity, to the extent of a half dozen or more, but some appear to be separated by wide intervals from any other bodies of coal. The coal of the several basins is laid upon an uneven floor and considerable differences of level are due to this fact." These statements regarding the Massillon field as a whole are all applicable to the portion in Wayne County.

Chippewa Township.—The Sharon coal outcrops in sections 24, 25, and 36 on both sides of Chippewa Valley. Its presence on the north side of the valley has already been mentioned in the discussion of the Sharon conglomerate (page 93), where the thickness is 2 feet 4 inches. It is underlain by a gray "fire clay," and overlain by sandstone.

In the former Chippewa mine in the northern part of Section 36 the coal averaged between 5 and 6 feet. The following record given by Read[2] for the shaft of this mine shows the thickness of the Sharon coal and the nature of the overlying strata.

[1]Orton, Edward, Massillon Coal Field, Geol. Surv. of Ohio, Vol. 5, 1884, p. 775.
[2]Read, M. C., Geol. Surv. of Ohio, Vol. 3, 1878, p. 532.

	Feet	Inches
Clay and shale	36	6
Sandstone	30	--
Clay shale	8	--
Iron ore	1	--
Clay shale	11	--
Sandstone	15	--
Gray sandstone	4	--
Shale	2	--
Bone coal / Good coal } *Sharon or No. 1*	1 4	6 —

The hill beneath which this mine is located appears to be entirely underlain with this coal for entries have been made on all sides. It is not known to exist west of sections 25 and 36 on the south side of Chippewa Valley.

In the northern part of the township the coal is not known to outcrop except along Chippewa Valley. It has never been mined west of sections 3 and 15, although to the east it is known to exist in nearly every section in the township. Drilling has failed to locate the coal immediately under Doylestown. The coal lies from 100 to 140 feet below the surface of the upland east of the village and has a thickness of 5 to 7 feet.

The Sharon coal usually exists in one bench, but in places it is divided into two benches separated by coarse sandstone. Such is the case in the Elm Run mine in the northern part of Section 12 where a one-foot bed above is separated from a bed 2 feet 8 inches thick by 2 feet of coarse gray sandstone. Read[1] reported a somewhat similar development on the John Adam's farm, 1 mile southeast of Doylestown, for which he gives the following section:

	Feet	Inches
Earth	14	--
Brown shale	18	--
Coarse white sandstone	22	--
Coal	3	--
Conglomerate	5	--
Coal	5	1
Black shale	--	6
Fire clay	2	--

In most places, however, the Sharon coal occurs without a parting.

Baughman Township.—The No. 1 coal is not known to outcrop in this township, although its horizon is slightly above the level of the valley near Burton City. It has been mined by drifting or shafting both north and south of this village. The section of the coal and the overlying strata is shown by the following record given by Read for the former mine of J. P. Burton in the northern part of Section 28.[1]

[1]Read, M. C., Geol. Surv. of Ohio, Vol. 3, 1878, pp. 532, 533.

A.—A small drift mine in the Sharon or No. 1 coal on the north side of Chippewa Valley. Note the sandstone roof.

B.—Preparing a pile of limestone for burning. Note the alternate layers of coal and limestone.

	Feet	Inches
Earth and gravel	13	--
Black shale	40	--
Sandstone	10	--
Black shale	--	3 to 4
Coal	4 to 7	--

In the eastern tier of sections the coal is below drainage, and is reached by shafts at a depth of 60 to 80 feet dependent on location. The thickness is similar to that near Burton City.

Sugar Creek Township.—In this township the Sharon coal wherever found is more than 125 feet below the surface and one mine in Section 24 has a shaft 232 feet deep. It occurs near Dalton at about 150 feet below the surface and also in the southeastern part of the township in sections 24 and 25. The thickness varies from 5 to 6 feet. South of Sugar Creek in Section 25 the coal has been reported by drillers, but it has decreased in thickness to less than 2 feet.

Paint Township.—The only occurrence of Sharon coal in this township is in the northeast corner of Section 1 where it is under cover. The thickness is reported to average about 4½ feet.

Sciotoville Clay

In the lower part of the Pottsville formation in the southern portion of the county is an impure, dark gray, flint clay. It was not recognized in the eastern part where the Sharon coal is developed, but because of its unusual lithology and its position in the lower part of the Pottsville it is classed as the Sciotoville clay.

The best exposure of this clay is along the highway in the central part of Section 24, Franklin Township, a short distance west of Fredericksburg. Here it is separated from the fine-grained Logan sandstone by about 15 feet of a light gray, clay-bonded sandstone, rather coarse in texture. In the following section, measured at this place, zones Nos. 3 and 4 are Sciotoville clay:

Pottsville formation.	Feet	Inches
17. Clay, gray siliceous (probably *Brookville horizon*)	3	--
16. Covered	17	--
15. Coal, *Tionesta or No. 5b*	--	8
14. Clay, gray	2	--
13. Sandstone and shale	10	--
12. Clay, shaly, gray blue	1	--
11. Covered	5	--
10. Iron ore, *Mercer horizon?*	--	2
9. Covered	4	--
8. Shale	2	--
7. Covered	28	6

Pottsville formation—Concluded.	Feet	Inches
6. Sandstone, gray	2	--
5. Covered	13	10
4. Clay, semi-flint, siliceous, ferruginous	2	--
3. Clay, flint, dark, impure, *Sciotoville*	2	2
2. Sandstone, gray, clay-bonded	15	6
Logan formation (Mississippian system).		
1. Fine-grained, yellowish-brown sandstone and grayish-blue shale	20	--

The relation of the Sciotoville clay to overlying members of the Pottsville is not very definitely shown in this section.

Along the highway leading over the hill southeast of Fredericksburg another outcrop of the Sciotoville clay shows it in a slightly different relationship than in the section just given. The clay, which is not so characteristically flinty as in the exposure at Fredericksburg, is overlain by coal, which, following Stout's usage in Muskingum County, is called the Anthony.[1] No other exposure of this coal was observed. The succession of beds at this place is as follows:

Pottsville formation (Pennsylvanian).	Feet	Inches
4. Coal, *Anthony*	--	3
3. Clay, plastic, *Sciotoville*	2	--
2. Sandstone, gray, clay-bonded	14	9
Logan formation (Mississippian).		
1. Fine-grained sandstone and shale	50	--

Only one other exposure of the clay was located, and this was along the highway in the south central part of Section 34, Franklin Township, where 18 inches of an impure flint clay outcrops in a bank on the north side of the road. The identification was based entirely on lithology since the overlying beds are not exposed. A few rods west of this a thin coal blossom outcrops at an elevation 20 to 30 feet lower than the clay. Its identity could not be determined.

Quakertown or No. 2 Coal

The Quakertown coal lies 55 to 65 feet above the Sharon or No. 1 from which it is separated by gray sandstone and shale.. Its thickness varies from a few inches to about 2½ feet, although for the most part it is less than 2 feet. It is known locally as the rider vein, as it is usually penetrated in drilling for the No. 1 coal. Most of the facts concerning the No. 2 coal are taken from drill records, since it is seldom seen at the outcrop.

[1]Stout, Wilber, Geol. Surv. of Ohio, Fourth Series Bull. 21, 1918, p. 54.

The relation to the Sharon coal is well shown in drill records reported by Orton for the Fox Lake Mine in NE. ¼ Section 12, Baughman Township.[1] The following record is typical of those reported by Orton for this mine:

	Feet
Surface	2
White shale or slate	6
Black slate	1
Grindstone rock	9
Black slate	1
Coal, *Quakertown or No. 2*	0.8
Fire clay	5
"Black band" (dark shale)	42
Hard, white sand rock	13
Slate	1
Coal, *Sharon or No. 1*	4.8

The interval between the two coal beds, as shown by the drill records given for this locality, varies from 58 to 68 feet, and the thickness of the Quakertown coal is reported from 8 inches to 2 feet.

Orton reported the presence of the rider seam (Quakertown coal) in the northeastern part of Chippewa Township.[2] In a shaft at the old Loomis mine in Section 2 this coal lies 12 feet below the surface and has a thickness of 2½ feet. About 1½ miles southeast of the latter place in SW. ¼ Section 12, a drift has at some time been opened to this coal. Because of its thinness and close proximity to the Sharon which is of excellent quality and four or five times as thick, the No. 2 coal is seldom mined, even where at its best.

In Section 21, Baughman Township, north of Burton City, the No. 2 coal outcrops along the highway just east of the central part of the section. A small area of No. 1 coal has been mined near here and the relation of the two coal beds which are separated by about 42 feet of sandstone and shale is shown by the following section:

Pottsville formation.	Feet	Inches
8. Shale	1	--
7. Coal, *Quakertown or No. 2*	--	10
6. Clay, gray, siliceous	2	--
5. Covered	9	4
4. Shale, dark	2	--
3. Covered	17	--
2. Sandstone, gray	3	--
1. Interval to road corner (approximate level of *Sharon or No. 1 coal*)	9	--

At numerous other places, as shown by drill records, the Quakertown coal is found with variable thickness. In some places it is reported as "black slate mixed with coal." The underlying fire clay and

[1]Orton, Edward, Geol. Surv. of Ohio, Vol. 5, 1884, p. 795.
[2]Idem., p. 790.

"black band" or dark shale are persistent, as is the white hard sandstone which to the driller indicates the proximity to the horizon of the Sharon coal.

The recognition of the Quakertown coal when away from its association with the Sharon bed is difficult. In the southern part of the county there are at a number of places thin coal beds near the base of the Pennsylvanian that probably are the equivalent of this bed, but with no guide rocks the identification cannot be satisfactorily made. Such is the case with the coal bed which was mined to a limited extent about ten years ago in Section 36, Clinton Township, on the farm of Elmer Brown where there is a small outlier of Pennsylvanian rocks. This bed is only about 30 feet above the base of the Pennsylvanian, but its definite identification is impossible. It is reported to be about 36 inches thick, the middle third being shaly.

Middle Mercer Coal and Clay

The Middle Mercer coal, which underlies the Lower Mercer limestone, is usually thin and of little importance. It lies either immediately under the limestone, or separated from it by a few inches of dark carbonaceous shales. The thickness varies from a few inches to about 15 inches. At no place in the county is it known to have minable thickness; however, about 1 mile from the county line near East Greenville in Stark County it thickens to a maximum of 3 feet 6 inches, and is reached by a shaft 70 feet deep. The lenticular form of the coal is shown by the fact that at the brick plant less than a mile west of this shaft it is practically wanting. There is a possibility of such a local thickening of the bed in Wayne County, but at no place was it more than 15 inches and this commonly is bone coal.

The underlying clay has a thickness of 3 to 8 feet, and is usually siliceous. Sections showing the position of this member may be found with the description of the Lower Mercer limestone.

Lower Mercer Limestone

The Lower Mercer is the lowest limestone in the Pennsylvanian system. It lies from 125 to 145 feet above the Sharon coal, 20 to 25 feet below the Upper Mercer limestone, and 60 to 70 feet below the Putnam Hill limestone. Its thickness varies from 1 to 4 feet.

This member is a dense, hard limestone, blue in color, but not as dark as the Upper Mercer. It is commonly spoken of as the blue limestone and is likely to be confused with the Upper Mercer, which lies about 20 feet above it and is also known as the blue limestone. The Lower Mercer in Wayne County is only slightly flinty and moderately dark blue.

The Lower Mercer limestone outcrops in Baughman, Sugar Creek, and Paint townships, but it was observed at a comparatively small number of places. Apparently it is not persistent over the entire area where due, its place being taken by shale or sandstone.

In a glaciated region like Wayne County, a single exposure commonly shows only two or three members, so to make clear the succession above the Middle Mercer coal the following section is introduced, which is given by Orton for an exposure 2 miles northwest of Bolivar in Tuscarawas County, about 12 miles east of the southeastern corner of Wayne County.[1]

		Feet	Inches
1.	Gray, or *Putnam Hill limestone*	2	--
2.	Concealed	25	--
3.	Coal, 1 ft. 9 in. Slate, 9 in. Coal, 2 ft. 4 in. } *Tionesta or No. 3b*	4	9
4.	Concealed	15	--
5.	Dark blue limestone, *Upper Mercer*	3	--
6.	Coal, thin, 4 to 6 in.	--	6
7.	Concealed	30	--
8.	Blue limestone, *Lower Mercer*	4	--
9.	Dark shale	2	--
10.	Coal, thin	--	--
11.	Dark shale	2	--
12.	Fire clay	6	--
13.	Concealed	20	--
14.	Blue limestone (occurs occasionally at this horizon)	1	6
15.	Concealed to canal	15	--

Orton reports that the Sharon coal is found at 125 to 180 feet below the Lower Mercer limestone near this place. The section shows the relation of a number of the more important beds. In Wayne County the intervals and thicknesses are not quite the same but the general relationships hold.

Baughman Township.—The most northerly outcrop of Lower Mercer limestone is in the eastern part of Section 24 where it occurs about 20 feet below the summit of the hill. The following drill record furnished by Mr. Wm. A. Eberly of North Lawrence shows its relation to the Sharon coal:

Drill record, NW. ¼ Section 24, Baughman Township

		Feet	Inches
15.	Drift	15	--
14.	Limestone (about in place), *Lower Mercer*	2	6
13.	Clay	1	6
12.	White soapstone	11	--
11.	Gray shale	15	--

[1]Orton, Edward, Geol. Surv. of Ohio, Vol. 5, 1884, p. 68.

Drill record, NW. ¼ Section 24, Baughman Township—Concluded

		Feet	Inches
10.	Sand shale	2	--
9.	Gray shale	25	--
8.	White soapstone	6	--
7.	Gray shale	20	--
6.	Coal smut and fire clay (*Quakertown or No. 2 coal* horizon)	--	3
5.	Gray shale	20	--
4.	Black band (shale)	2	--
3.	Dark gray rock	13	--
2.	Soft dark shale (*Sharon or No. 1 coal* horizon)	--	6
1.	Gray rock	29	6

In this section the interval between the No. 1 and No. 2 coals is about 35 feet which is 20 feet less than the average. The interval between the No. 1 coal and the Lower Mercer limestone is 147 feet.

The following section, measured along the highway one-half mile north of Fox Run in Stark County, shows more in detail the beds beneath the Lower Mercer limestone:

Section one-half mile north of Fox Run, Stark County

		Feet	Inches
15.	Limestone, blue-gray, *Lower Mercer*	2	--
14.	Coal blossom, *Middle Mercer*	--	6
13.	Clay, gray	2	--
12.	Interval	62	--
11.	Iron ore, kidney	--	4
10.	Coal blossom, *Van Dusen*	--	2
9.	Clay, gray	2	--
8.	Shale, brown	1	--
7.	Shale, yellow and gray, and covered	10	4
6.	Sandstone, gray	6	--
5.	Clay, yellowish-gray	2	--
4.	Coal blossom, *Quakertown or No. 2*	--	10
3.	Clay, gray	5	4
2.	Sandstone, thin-bedded, gray	3	--
1.	Shale, dark brown	3	4

Here the interval from the No. 2 coal to the Lower Mercer limestone is 80 feet, and from the Lower Mercer to the Sharon coal it is approximately 140 feet, as the No. 2 coal lies about 60 feet above the Sharon. It is to be noted that the coal underlying the Lower Mercer limestone is thin and unimportant. The name Van Dusen, given to the thin coal bed about 64 feet below the limestone, is taken from Stout's classification for Muskingum County, where the corresponding interval is about 58 feet.[1]

[1]Stout, Wilber, Geol. Surv. of Ohio, Fourth Series Bull. 21, 1918, p. 61.

Sugar Creek Township.—The Lower Mercer limestone has been encountered in drilling in the northwestern part of this township. In the first mile east of the county line near the Lincoln Highway this limestone has been penetrated in a test hole at the brick plant and also in the Battle Axe mine, which is located just west of East Greenville where the succession of beds is as follows:

		Feet	Inches
6.	Coal, probably *Bedford*	1	10
5.	Interval, about	5	--
4.	Limestone, blue, dense, fossiliferous, *Lower Mercer*	4	--
3.	Shale, black, fossiliferous	--	2
2.	Coal, *Middle Mercer*	3	6
1.	Clay, gray, unmeasured.		

The shaft at the mine is reported to be 70 feet deep. The thickness of both the limestone and coal is unusual, but it is reported that the coal has entirely disappeared within less than a half mile to the west. The Sharon coal lies between 115 and 125 feet below the limestone.

The relation of the two Mercer limestones is very well shown along the highway and in a ravine just east of the center of Section 9 where the following rocks were measured:

		Feet	Inches
7.	Limestone, dark blue, flinty, *Upper Mercer*	--	6
6.	Coal blossom, *Bedford*	--	10
5.	Interval	27	--
4.	Limestone, blue, *Lower Mercer*	--	10
3.	Interval	8	9
2.	Iron ore, *Boggs horizon*	--	6
1.	Clay shale, dark greenish-gray	2	8

The name for the ore is taken from Stout's classification for Muskingum County, where the Boggs member is either a limestone, flint, or ore, or a combination of any of these.[1] It was not recognized elsewhere in Wayne County.

In the southern part of the township a limestone bed outcrops which, because of its position at more than 60 feet below the Putnam Hill limestone, should be the Lower Mercer. In SW. ¼ Section 28, about 2 feet 2 inches of blue gray fossiliferous limestone was penetrated in drilling near the Boone School in Section 27.

Paint Township.—The Lower Mercer limestone is exposed in a ravine in the northwestern part of Section 17. It outcrops on a slope south of the highway, and the Putnam Hill limestone was observed to the north near the crossroads. A section measured at this place follows:

[1]Stout, Wilber, Geol. Surv. of Ohio, Fourth Series Bull. No. 21, 1918, p. 70.

Strata measured in the northwest quarter of Section 17, Paint Township

		Feet	Inches
16.	Limestone, gray, *Putnam Hill*	3	8
15.	Coal, *Brookville or No. 4*	2	4
14.	Clay, gray	7	6
13.	Coal smut	1	--
12.	Clay, gray	3	--
11.	Interval	21	7
10.	Shale, gray	--	5
9.	Limestone, blue gray, *Lower Mercer*	1	9
8.	Shale, dark carbonaceous	1	2
7.	Coal, bone } *Middle Mercer*	1	3
6.	Shale, dark } *Middle Mercer*	--	2
5.	Clay, light, siliceous	5	5
4.	Clay, shale, dark	1	10
3.	Coal, bone, *Flint Ridge*	--	2
2.	Clay, dark	1	--
1.	Clay, light gray	2	--

The total interval between the two limestones is 61 feet. The identification of the Flint Ridge coal horizon follows Stout's classification for Muskingum County.[1]

If the Lower Mercer limestone is developed in Franklin and Salt Creek townships it is everywhere under cover. Its presence might be suspected from the fact that it is exposed in the townships to the south in Holmes County. On the other hand it is not always present where due, the horizon being occupied by sandstone or shale.

Fossils.—The Lower Mercer limestone is characterized by an abundance of fossils, and where separated from the underlying coal by a few inches of shale, this is also fossiliferous. At the shaft mine 2½ miles east of Dalton near East Greenville in Stark County, the coal underlying this limestone is being mined. In connection with putting down the shaft a considerable quantity of the Lower Mercer limestone and the shale which separates it from the underlying coal was thrown out. This material is very fossiliferous, and from it the following specimens were identified by Miss Helen Morningstar:

Lower Mercer Limestone

Crinoid segments abundant.
Lophophyllum profundum (Milne-Edwards & Haine).
Fenestella limbata Foerste.
Orbiculoidea meekana (Whitfield).
Derbya crassa (Meek & Hayden).
Chonetes mesolobus Norwood & Pratten
Productus cora d'Orbigny.
Productus semireticulatus (Martin).

[1]Stout, Wilber, Geol. Surv. of Ohio, Fourth Series Bull. 21, 1918, p. 75.

Lower Mercer Limestone—Concluded.

Pustula nebraskensis (Owen).
Chonetes mesolobus Norwood & Pratten.
Marginifera muricata var. missouriensis Girty.
Spirifer cameratus Morton.
Spirifer opimus Hall.
Squamularia perplexa (McChesney).
Composita subtilita (Hall).
Crenipecten foerstii Herrick.

Lower Mercer black shale

Crinoid segments.
Orbiculoidea meekana (Whitfield).
Derbya crassa (Meek & Hayden).
Chonetes mesolobus Norwood & Pratten.
Productus cora d'Orbigny.
Productus semireticulatus (Martin).
Pustula nebraskensis (Owen).
Marginifera wabashensis (Norwood & Pratten).
Marginifera muricata var. missouriensis Girty.
Rhipidomella pecosi (Marcou).
Spiriferina kentuckyensis (Shumard).
Spirifer cameratus Morton.
Spirifer opimus Hall.
Squamularia perplexa (McChesney).
Composita subtilita (Hall).
Parallelodon carbonarius (Cox).
Parallelodon obsoletus (Meek).
Parallelodon tenuistriatus (Meek & Worthen).
Aviculopecten coxanus Meek & Worthen.
Acanthopecten carboniferous (Stevens).
Entolium aviculatum (Swallow).
Allerisma costatum Meek & Worthen.
Allerisma terminale Hall.
Pleurophorus tropidophorus Meek.
Astartella varica McChesney.
Astartella vera Hall.
Plagioglypta meekianum (Geinitz).
Bellerophon percarinatus Conrad.
Euphemus nodocarinatus Hall.
Phanerotrema grayvillensis (Norwood & Pratten).
Pleurotomaria carbonaria Norwood & Pratten.
Pleurotomaria newportensis White.
Schizostomia catilloides (Conrad).
Naticopsis nanus Meek & Worthen.
Naticopsis pulchella Morningstar mss.
Sphaerodoma regularis (Cox).
Sphaerodoma brevis (White).
Bullimorpha inornata Meek & Worthen.
Pseudorthoceras knoxense (McChesney).

Bedford Coal and Clay

The Bedford coal, except in one locality, is thin and of little importance but the underlying siliceous clay is from 8 to 15 feet in thickness, and in one place at least has been used for ceramic purposes. The coal occurs just beneath the Upper Mercer limestone, and seldom has a thickness of more than 1 foot. It outcrops in Sugar Creek, Paint, Salt Creek, and Franklin townships. Its character and thickness are shown in most of the sections of the Upper Mercer limestone.

The only place where the coal has sufficient thickness to be of any importance is in the north central part of Salt Creek Township, in Section 4, where the thickness and quality are such that it formerly was mined. Read reports that at one place where a drift was made into a hill the coal at the outcrop was 6 feet thick, but in 50 yards it was reduced to a knife edge.[1] He gives the following section for the coal on the Daniel Rehm farm in Section 8, Salt Creek Township:

	Feet	Inches
Limestone	4 to 6	--
Coal	1	8½
Shale	--	4
Coal	3	5
Shale	--	1
Coal	--	8

The total thickness of the coal is 5 feet 9½ inches, which is much greater than is usually found even in the immediate vicinity. Read placed this coal under the Lower Mercer limestone, but it is here classed as the Bedford and is overlain by the Upper Mercer limestone. The basis for this is given under the discussion of the Upper Mercer limestone (page 108).

The relation of this coal to the overlying limestone and also to the Putnam Hill is shown in the following section measured in the NE. ¼ Section 33, Salt Creek Township, Holmes County, about 1 mile south of the county line. The coal is shown in a drift mine, and the Putnam Hill limestone is being quarried on the hill above.

			Feet	Inches
5.	Limestone, gray, *Putnam Hill*		5	--
4.	Interval		43	6
3.	Flint	*Upper Mercer*	2	--
	Limestone, dark blue, fossiliferous		4	--
2.	Coal, good	*Bedford*	1	--
	Coal, cannel		--	5
	Clay		--	1
	Coal		1	--
1.	Clay, light, plastic		4	--

[1]Read, M. C., Geol. Surv. of Ohio, Vol. 3, 1878, p. 535.

A coal bed is reported 20 feet below the Bedford, which may be the coal associated with the Lower Mercer limestone. The interval between the two limestones is similar to that in Franklin and Paint townships. The coal is much thicker than is usual for the Bedford in Wayne County, but it has some resemblance to the development in Section 8, Salt Creek Township. For the most part it is thin and of very poor quality.

Upper Mercer Limestone

The Upper Mercer limestone outcrops where due at comparatively few places in the county, although it has been recognized in four different townships. It is usually known as the blue limestone because of its dark blue color. In addition to its color the hard flinty nature of much of the member is especially noticeable. When encountered in drilling it is always recognized because of the difficulty in penetrating it. Attempts have been made to burn the stone for agricultural lime, but as it was largely flint the results were unsuccessful.

The position of this bed is about 20 or 25 feet above the Lower Mercer limestone and 45 to 50 feet below the Putnam Hill. Its thickness varies from 1 to 3 feet, with an average of a little less than 2 feet.

Sugar Creek Township.—The most northerly exposure of the Upper Mercer limestone is southwest of Dalton in the east central part of Section 9, where the underlying clay is being removed for a stoneware plant at Dalton. The succession of beds is as follows:

		Feet	Inches
4.	Limestone, largely flint, dark blue to black, *Upper Mercer*	1	8
3.	Coal, soft, *Bedford*	1	--
2.	Clay, upper part gray, lower part dark, siliceous	8	--
1.	Sandstone, unmeasured.		

The limestone has a very thin covering of drift, and is so thoroughly weathered that only the flint remains.

Other exposures in Section 14 (page 110) show a thickness of 1 to 2 feet of blue limestone which contains a rather small proportion of flint.

Paint Township.—Only one exposure of the Upper Mercer limestone was noted in this township, although the hard blue limestone was reported in drilling for water in the vicinity of Mt. Eaton. Near the center of Section 24 this member is exposed along the highway, and on the hillside a short distance to the east the Putnam Hill limestone has been quarried. The relation of the beds is as follows:

		Feet	Inches
6.	Limestone, gray, *Putnam Hill*	4	--
5.	Interval	45	--
4.	Limestone, dark blue, flinty, *Upper Mercer*	2	6
3.	Coal blossom, *Bedford*	1	--
2.	Clay and covered	5	--
1.	Sandstone	20	--

This exposure is very typical in that the limestone is characteristically developed, and the interval to the Putnam Hill is about the average. It is interesting to note that the underlying sandstones occupy the horizon of the Lower Mercer limestone. In all probability such a condition as this is responsible for the failure of both of these limestones to appear at numerous places where due.

Salt Creek Township.—The Upper Mercer limestone outcrops in sections 3, 4, and 9 and in the last section is exposed in a creek bed near where the ravine is crossed by the highway, just south of the central part of the section. A short distance southwest from the road the following section was measured:

		Feet	Inches
3.	Shale, yellowish-gray	10	--
2.	Limestone, blue, in two beds (6 and 18 inch), fossiliferous, *Upper Mercer*	2	--
1.	Coal blossom, *Bedford*	--	6

There may be some question as to whether this limestone is Upper or Lower Mercer, but there are no other beds of importance either above or below exposed within two miles that would aid in identification. Since it has the characteristic blue color and lies at an elevation not more than 30 feet below the nearest outcrop of Putnam Hill, it is called the Upper Mercer.

Franklin Township.—The only outcrops of the Upper Mercer limestone are in the southeastern part of Section 21 where the succession of beds along the east and west road is as follows:

		Feet	Inches
6.	Shale	--	6
5.	Ore	--	4
4.	Limestone, dark blue, fossiliferous, *Upper Mercer*	1	4
3.	Ore	--	4
2.	Clay, dark	2	--
1.	Clay, gray	5	--

The interval to the Putnam Hill, which outcrops at the base of Munser Knob nearby, is between 45 and 48 feet. The Lower Mercer limestone is lacking here, but certain ore horizons may be the equivalent.

The relation of the Putnam Hill and Upper Mercer limestones is well shown about one-half mile south of the county line in Section 25, Prairie Township, Holmes County, near the center of which section the following rocks were measured:

		Feet	Inches
5.	Limestone, gray, *Putnam Hill*	5	2
4.	Coal, *Brookville or No. 4* (reported)	4	--
3.	Interval	37	--
2.	Limestone, blue, *Upper Mercer*	1	10
1.	Coal	2	--
	Clay, gray	3	--
	Coal	1	6
	Bedford		

The coal which is lacking near Munser Knob has appeared with considerable thickness.

Fossils.—The character of the fauna of the Upper Mercer limestone is shown by the following list of specimens collected in NE. ¼ Section 33, Salt Creek Township, Holmes County, just 1 mile south of the county line where the underlying coal is being mined. The identifications were made by Miss Helen Morningstar.

Crinoid segments abundant.
Fenestella limbata Foerste.
Derbya crassa (Meek & Hayden).
Chonetes mesolobus Norwood & Pratten.
Productus cora d'Orbigny.
Productus semireticulatus (Martin).
Pustula nebraskensis (Owen).
Pustula symmetrica (McChesney).
Marginifera wabashensis (Norwood & Pratten)
Marginifera muricata var. missouriensis Girty.
Spirifer opimus Hall.
Squamularia perplexa (McChesney).
Composita subtilita (Hall).
Prothyris elegans Meek.
Crenipecten foerstii Herrick.
Sphaerodoma brevis White.

Tionesta or No. 3b Coal

The Tionesta or No. 3b coal occurs between the Upper Mercer or blue limestone and the Putnam Hill or gray limestone. It commonly lies 15 to 25 feet above the former and an equal or slightly greater distance below the latter. The thickness varies from 1 to 2 feet, although in places it increases to 2 feet 6 inches. The overlying beds are almost invariably sandstone, hence the name "sandstone vein." Frequently it is absent from the horizon where due, its place being taken by sandstone and shale. Because of this irregularity its actual distribution is difficult to determine.

In Sugar Creek Township it outcrops in sections 12 and 14. Its relation to the Putnam Hill limestone is shown in the following record measured a short distance south of the school house in Section 12. The Tionesta coal outcrops along the highway, and the limestone is exposed in the field to the east.

		Feet	Inches
4.	Limestone, gray, *Putnam Hill*, unmeasured.		
3.	Interval, approximately	28	--
2.	Coal, soft, *Tionesta or No. 3b*	2	--
1.	Clay, gray, siliceous	4	--

The relation of the Tionesta or No. 3b coal to the Upper Mercer limestone in the same locality is shown in an exposure along the highway a short distance west of the center of Section 14.

		Feet	Inches
7.	Coal blossom, *Tionesta or No. 3b*	--	6
6.	Clay, gray, siliceous	2	4
5.	Sandstone, gray, clay-bonded	1	6
4.	Ore	--	6
3.	Shales, sandy with thin sandstone beds	20	--
2.	Limestone, blue gray, *Upper Mercer*	1	--
1.	Clay, gray	2	--

The only other exposure of the Tionesta coal in this township is near the south central part of Section 28 where the interval to the Putnam Hill limestone is between 30 and 35 feet.

The Tionesta coal is not known to outcrop in Paint Township, but an old drift mine in the SW. ¼ Section 10, just west of Mt. Eaton, is located at about the correct interval below the Putnam Hill limestone though the identification could not be confirmed. A coal bed which is reported to lie 30 feet below the limestone, may be on the Tionesta horizon.

To the west the Tionesta coal was recognized in two places only. In the NE. ¼ Section 13, Salt Creek Township, the following section was measured in the ravine and along the highway:

		Feet	Inches
5.	Coal blossom, *Brookville or No. 4*	--	10
4.	Interval	22	--
3.	Sandstone, shaly	4	--
2.	Coal, *Tionesta or No. 3b*	2	--
1.	Clay, gray, plastic	3	--

The presence of a few fragments of gray limestone near the outcrop of the upper coal would seem to confirm the identification of that bed. The Tionesta here is variable in altitude and thickness. On the west side of the road the upper surface of the coal is 3 feet 6 inches higher than it is to the east; the thickness, however, is only one-half as great.

About 1½ miles to the southwest beds on this horizon are exposed in a ravine in the southern part of Section 14, Salt Creek Township. The nature of the beds is shown by the section which follows:

		Feet	Inches
7.	Limestone, gray, *Putnam Hill*	2	--
6.	Coal, *Brookville or No. 4*	3	--
5.	Clay, gray, siliceous	4	--
4.	Interval	30	--
3.	Sandstone, shaly, thin-bedded	4	6
2.	Coal, *Tionesta or No. 3b*	2	8
1.	Clay, dark, siliceous	6	--

The interval between the two coals is slightly greater than in the preceding section, but probably no more so than can be expected for a bed as variable as the Tionesta appears to be. Its changeable nature is well brought out by the fact that less than one-eighth mile farther up this ravine the total thickness of the coal is 10 inches.

ALLEGHENY FORMATION

The Allegheny formation is confined to a comparatively small area in the southern and southeastern parts of the county where it caps the highest hills. It contains the only coals of any importance in the county above the Sharon or No. 1 and also the most important limestone member. Only the lower part of the formation is developed, the total thickness being about 95 feet.

The horizon plane which separates the Allegheny from the Pottsville formation is the base of the Brookville or No. 4 coal. This division is purely arbitrary in Ohio and is not based on any lithological, structural, or faunal evidence. A generalized section of the Allegheny formation of Wayne County is given below:

Allegheny Formation.	Feet	Inches
6. Sandstone and shale	50	--
5. Coal, *Lower Kittanning or No. 5*	3	--
4. Clay, siliceous	5	6
3. Sandstone and shale	30	--
2. Limestone, gray, *Putnam Hill*	3	6
1. Coal, *Brookville or No. 4*	2	6
Total thickness	94	6

Brookville or No. 4 Coal and Clay

The Brookville coal and its associated clay occur immediately under the Putnam Hill limestone. The thickness of the coal varies from a few inches to 3 feet, with an average of about 2 feet 4 inches, that of the clay from 3 to 8 feet. The coal in places is thin and shaly, even though the overlying limestone occurs in considerable thickness. The No. 4 coal is exposed in Sugar Creek, Paint, Salt Creek, and Franklin townships.

Sugar Creek Township.—The Brookville coal is exposed along the highway in the south central part of Section 26 where it has a thickness of 2 feet 4 inches (page 113). At the outcrop it is soft, and much weathered. Elsewhere in the township the beds underlying the Putnam Hill limestone are not exposed.

Paint Township.—The Brookville coal and its associated clay are exposed at a number of places in the more elevated portions of the

southern half of the township. The thickness of the coal seldom exceeds 30 inches and more often is between 24 and 26.

The following succession of beds is shown in a small quarry in the south central part of Section 8 just north of the crossroads. The coal is bright and rather hard, and has been used to a limited extent by farmers in burning lime.

		Feet	Inches
3.	Limestone, gray, fossiliferous, *Putnam Hill*	3	8
2.	Coal, *Brookville or No. 4*	2	4
1.	Clay, gray	7	6

About a mile east, the Brookville coal outcrops near the hilltop where it is only 12 inches or less in thickness. East of Mt. Eaton it ranges from 22 to 26 inches as may be seen in certain of the sections given under the discussion of the Putnam Hill limestone and Lower Kittanning coal. Only in the SW. ¼ Section 12, does the thickness reach 3 feet.

Salt Creek Township.—The Brookville coal and its associated beds outcrop in Section 23 where in the southeast quarter the coal was formerly extensively mined on the Stutz farm. The thickness of the coal in this mine is shown by the following section, which was reported by the owner of the farm:

			Feet	Inches
2.	Limestone, gray, *Putnam Hill*		4	--
1.	Coal, fair	*Brookville or No. 4*	--	6
	Shale parting		--	2
	Coal, bright, hard		2	--

The thickness of the coal here is about equal to that found in the vicinity of Mt. Eaton.

Franklin Township.—With the exception of a small area in sections 3 and 10, the Brookville coal is confined to the southeastern part of the township. At the mine of the Cherry Valley Coal Company in the southern part of Section 24 the coal is 3 feet thick (page 114) and the underlying clay 6 feet, both of which are being mined. About 1½ miles west at the southern end of Sterrett Knob the following beds are exposed in an entry into the hill.

		Feet	Inches
3.	Limestone, gray, *Putnam Hill*	4	9
2.	Coal, *Brookville or No. 4*	3	--
1.	Clay, gray, siliceous	2	--

A mile west near the base of Munser Knob the thickness of the coal is 2 feet 7 inches.

Putnam Hill Limestone

The Putnam Hill is the most important limestone of the Pennsylvanian in the county. Its thickness varies from 1 to 5½ feet with an average of more than 3 feet. It outcrops in Sugar Creek, Paint, Salt Creek, and Franklin townships. This bed lies immediately over the Brookville coal except where the two are separated by one or two inches of shale. The interval to the underlying Upper Mercer limestone is between 45 and 50 feet and to the Lower Mercer limestone between 60 and 70 feet.

The Putnam Hill is a hard, dense, gray limestone, which is known locally as the "gray limestone" to distinguish it from the Upper Mercer which is the "blue limestone." It is commonly spoken of as a "plate limestone," because of a tendency to split into beds of 2 to 4 inches, as a result of which it can be easily quarried, but where well under cover it tends to be more massive. It is everywhere quite fossiliferous.

Because of its persistence the Putnam Hill limestone is one of the best guides in the county for determining the various horizons of upper Pottsville and lower Allegheny formations. Stout has indicated that it is well developed in Stark County and also that it can be traced south as far as Perry County.[1]

Sugar Creek Township.—The most northerly exposure of the Putnam Hill limestone is in the southwest quarter of Section 12 where it appears at the surface in a field. Its thickness could not be determined, although outcrops were noted at a number of places.

Two miles southwest in NE. ¼ Section 22, the hilltop appears to have about the proper elevation for the Putnam Hill limestone, but gray sandstone outcrops to its crest and apparently occupies the place of the limestone.

South of Sugar Creek Valley, this member is exposed in the higher hills. In the field just back of the Boone School in Section 27, also along the highway in the south central part of Section 26, exposures were noted. At the latter place the following section was measured along the highway:

		Feet	Inches
4.	Limestone, *Putnam Hill*	2	4
3.	Coal, *Brookville or No. 4*	2	4
2.	Interval	22	5
1.	Sandstone, gray	10	--

Paint Township.—The Putnam Hill limestone has its most extensive distribution in this township, where it underlies practically all of the upland with an elevation of 1,200 feet or more above sea level. It occurs in greatest thickness south of Mt. Eaton near the county

[1]Stout, Wilber, Geol. Surv. of Ohio, Fourth Series Bull. 21, 1918, p. 129.

line. In the southwest corner of Section 22 in a ravine just west of the highway, the following beds are exposed:

		Feet	Inches
4.	Limestone, gray, fossiliferous, *Putnam Hill*	5	--
3.	Shale	--	2
2.	Coal, *Brookville or No. 4*	2	8
1.	Clay, gray	1	--

This was the greatest thickness observed in the township, although in the southwest corner of Section 16 it is equaled. In other exposures it ranges from 2 feet 4 inches to 3 feet 8 inches.

Where the limestone is overlain by a few feet of drift only, as in the south central part of Section 8, it shows much weathering along joint planes and breaks up readily into slabs 2 to 4 inches thick which makes quarrying operations comparatively easy. Where under cover of considerable thickness it appears to be more massive.

Salt Creek Township.—The Putnam Hill or "gray limestone" outcrops at a number of places in the southeastern part of the township. In the central part of Section 23, just north of the highway, it occurs as follows:

		Feet
2.	Limestone, gray, fossiliferous, *Putnam Hill*	4
1.	Coal, *Brookville or No. 4*	3

The underlying coal has been mined extensively in this locality, and a second coal bed, probably the Tionesta, is reported at about 30 feet below the limestone.

Franklin Township.—The Putnam Hill limestone is developed in good thickness in this township where it averages about 4 feet and at a number of places exceeds 5 feet. The most northerly exposure is in sections 3 and 10 about 1½ miles east of Moorland, where it has been quarried along the highway. The thickness here is more than 3 feet, but the underlying coal is thin.

In the southern part of the township there are numerous exposures in the vicinity of Munser and Sterrett knobs. North of the former, over quite an area, the limestone lies within 5 to 8 feet of the surface, and in places has a thickness of 5 feet. In the SW. ¼ Section 24, about one-fourth mile from the county line, it forms the roof in a drift mine where the Brookville coal and the underlying clay are being taken out. The succession of beds at this place is as follows:

		Feet	Inches
6.	Coal, thickness variable, *Lower Kittanning or No. 5*, average	3	--
5.	Interval	37	--
4.	Limestone, gray, *Putnam Hill*	4	--
3.	Shale, fossiliferous	--	3
2.	Coal, *Brookville or No. 4*	3	--
1.	Clay, siliceous, gray	6	--

Fossils.—The Putnam Hill limestone commonly is fossiliferous. In a collection made at an outcrop 1¼ miles east of Moorland in Section 3, Franklin Township, the following specimens were identified:

Crinoid segments.
Fusulina secalica (Say).
Spirifer cameratus Morton.
Spirifer opimus Hall.
Spirifer boonensis Swallow?
Spiriferina kentuckyensis (Shumard).
Squamulara perplexa (McChesney).
Composita subtilita (Hall).

Lower Kittanning or No. 5 Coal and Clay

The Lower Kittanning coal and its associated clay are the highest members of importance in the Pennsylvanian of Wayne County. The coal lies 15 to 30 feet above the Putnam Hill limestone, from which it is usually separated by gray sandstone, and has a thickness which varies from 1 foot to 3 feet 8 inches. At one place less than one-half mile east of the county line a thickness of 6 feet was noted. Its development is confined to the higher hills of the southern and southeastern parts of the county.

Sugar Creek Township.—The Lower Kittanning coal outcrops at one place in this township, namely along the county line in the eastern part of Section 12 where it is exposed along the highway, and has a thickness of about 2 feet. The interval to the Putnam Hill limestone, which outcrops about a mile to the northwest, is not more than 20 feet.

About one-half mile east in Stark County, the No. 5 coal has been mined by stripping. At one place the coal had the following thickness:

			Feet	Inches
3.	Drift.			
	Coal	*Lower Kittanning or No. 5*	3	--
2.	Pyrite		--	1
	Coal		3	--
1.	Fire clay, unmeasured.			

The coal varies in thickness from 3 to 6 feet, and the irregular nature of the floor is especially noticeable. The coal shows a comparatively small degree of weathering, considering the shallow covering of drift.

The only other places in the township which have an elevation high enough for this coal are in the southern part in sections 26 and 27. Its presence was not confirmed, although it is known that Putnam Hill limestone outcrops in both sections.

Paint Township.—By far the most important development of the Lower Kittanning coal in Paint Township is in the vicinity of Mt. Eaton where it underlies the hill on which the village is located, but

it also outcrops on a number of the higher hills of the township. South of Mt. Eaton it has a thickness of 3 feet to 3 feet 8 inches, and the roof is reported to be shale. It outcrops along the highway northeast of the village where the relation to the Putnam Hill limestone is shown. The following section was measured along the West Lebanon-Mt. Eaton pike:

		Feet	Inches
5.	Coal blossom, *Lower Kittanning or No. 5*	--	6
4.	Interval	20	6
3.	Limestone, *Putnam Hill*	2	6
2.	Coal blossom, *Brookville or No. 4*	--	8
1.	Clay, gray	14	--

The nature of the beds underneath the coal is shown in the following section measured along the highway in the SW. ¼ Section 14, about 1½ miles southeast of Mt. Eaton:

		Feet	Inches
5.	Drift	5	--
4.	Coal, soft	--	10
	Coal *Lower Kittanning or No. 5*	1	6
3.	Clay, gray	6	--
2.	Ore, nodules	--	3
1.	Shale	11	--

The interval between the Putnam Hill limestone and No. 5 coal is commonly occupied quite largely by sandstone, although there may be a considerable thickness of shale. The following section measured along the diagonal road in the south central part of Section 11, Paint Township, shows in part the nature of the strata underlying the Lower Kittanning coal:

		Feet	Inches
10.	Coal, *Lower Kittanning or No. 5*	1	4
9.	Clay, gray	5	3
8.	Clay, yellow	1	2
7.	Sandstone, gray, clay-bonded	15	10
6.	Interval, covered	8	--
5.	Limestone, gray, fossiliferous, *Putnam Hill*	1	2
4.	Coal, *Brookville or No. 4*	--	10
3.	Clay, gray, plastic	2	--
2.	Clay, gray, siliceous	4	--
1.	Sandstone, gray, thin-bedded	20	--

All of the beds which separate these two members were not seen in any one exposure, but the various members were observed at different places and in every case were either sandstone or shale. In the section above, the total interval between the top of the Putnam Hill and base of the No. 5 coal is 31 feet 3 inches.

In the southern part of the township the Lower Kittanning coal is usually overlain by a considerable thickness of coarse sandstone. Such is the case south of Mt. Eaton, also in the hill east of Rockdale schoolhouse in Section 24, as is shown in the following section measured along the Mt. Eaton-Wilmot pike:

		Feet	Inches
9.	Sandstone, gray, and covered	50	8
8.	Interval	26	--
7.	Coal blossom, *Lower Kittanning or No. 5*	1	--
6.	Clay, gray	6	--
5.	Interval	29	2
4.	Limestone, gray, *Putnam Hill*	3	4
3.	Coal blossom, *Brookville or No. 4*	2	--
2.	Interval	9	6
1.	Sandstone, gray, thin-bedded, shaly	6	--

The hill on which this sandstone outcrops (Zone 9) is covered with talus composed of sand and huge blocks of sandstone. Whether or not the entire thickness of this zone is sandstone could not be determined.

At one place only was there any suggestion of coal beds above the Lower Kittanning and that was in the south part of Section 12 on the southern slope of the hill along the highway, where the following section was measured:

		Feet	Inches
9.	Coal blossom	--	6
8.	Interval	48	--
7.	Coal blossom	--	8
6.	Interval	8	8
5.	Shale	4	--
4.	Coal, *Lower Kittanning or No. 5*	2	8
3.	Interval	14	--
2.	Limestone, *Putnam Hill*, unmeasured	--	--
1.	Coal blossom, *Brookville or No. 4*, unmeasured	--	--

The Lower Kittanning coal was observed in a mine near the base of the higher part of the hill, and the Putnam Hill limestone outcrops on the north slope. The thin coal blossoms exposed along the highway above the mine may possibly be outliers of the next higher coal beds which are exposed extensively in the counties to the south. If such is the case the lower one might be the Middle Kittanning or No. 6 and the one above the Lower Freeport or No. 6a, but there is not sufficient evidence to confirm such an identification.

Salt Creek Township.—The Lower Kittanning coal is not known to outcrop in this township. If present it would be confined to the higher areas south of Maysville where the highest knobs reach an elevation of more than 100 feet above the Putnam Hill limestone. How-

ever, most of the slopes are covered with a rather heavy mantle of glacial drift, as a result of which rock outcrops are few in number.

Franklin Township.—West of Mt. Eaton the Lower Kittanning coal is not known to be exposed except in Franklin Township. It has been mined in Section 24, also in the section to the south in Holmes County. The thickness varies from 2 to 4 feet, and the distance above the Putnam Hill limestone is about 38 feet.

To the west in sections 22 and 23 the No. 5 coal is reported to be present in Sterrett and Munser knobs, although it was not seen at the outcrop. Putnam Hill limestone is exposed near the base of these knobs and massive sandstone, probably overlying the No. 5 coal, caps them.

PART III

ECONOMIC GEOLOGY

CHAPTER VI

Although Wayne County is distinctly agricultural, its mineral resources have added considerably to its wealth. Especially is this true of oil and gas. Coal has been mined extensively, although over a rather limited area. Other economic materials include clay and shale, salt, molding sand, limestone, building stone, and road material.

OIL AND GAS

The beginning of oil and gas production in Ohio dates from 1860 when oil was discovered on Duck Creek at Macksburg, Washington County. The first discovery of gas in large quantity was at Findlay, Hancock County, in 1884, and the following year oil was discovered in the same locality. In 1887 natural gas was struck at Lancaster in the "Clinton sand" and by extensive drilling to this rock the greatest gas field in the world has been developed. The field consists at present of one great area extending from Knox County on the north to Vinton on the south, and smaller fields in Holmes, Ashland, Wayne, Medina, Lorain, and Cuyahoga counties. Oil was discovered in paying quantities in the "Clinton" in 1907 near Bremen, Fairfield County. Since then the producing territory in central Ohio has been extended northeast in Muskingum and Coshocton counties and south in Hocking County. In northern Ohio the territory in which the "Clinton sand" has produced oil is confined largely to Wayne County, but even there the area is small.

History and Development in Wayne County

With the discovery of natural gas at Findlay in 1884 the search for this mineral wealth was stimulated in all parts of the State. That Wayne County was included in this is shown by the fact that in "1885 a test well was drilled within the corporation limits of Wooster. The Berea was found at 590 feet and was 65 feet thick. Work continued until a depth of 2,000 feet was reached and then the well was abandoned. It was a total failure."[1] During the next five years a number

[1]Bownocker, J. A., Geol. Surv. of Ohio, Fourth Series Bull. 1, 1903, pp. 285-286.

of wells were drilled in the vicinity of Wooster and Dalton. Invariably the Berea sand was penetrated and drilling continued to about 2,000 feet, this being the depth of the gas-bearing sand in the Lancaster field which was being so successfully developed during this same period. In all cases the results were the same—the wells were failures.

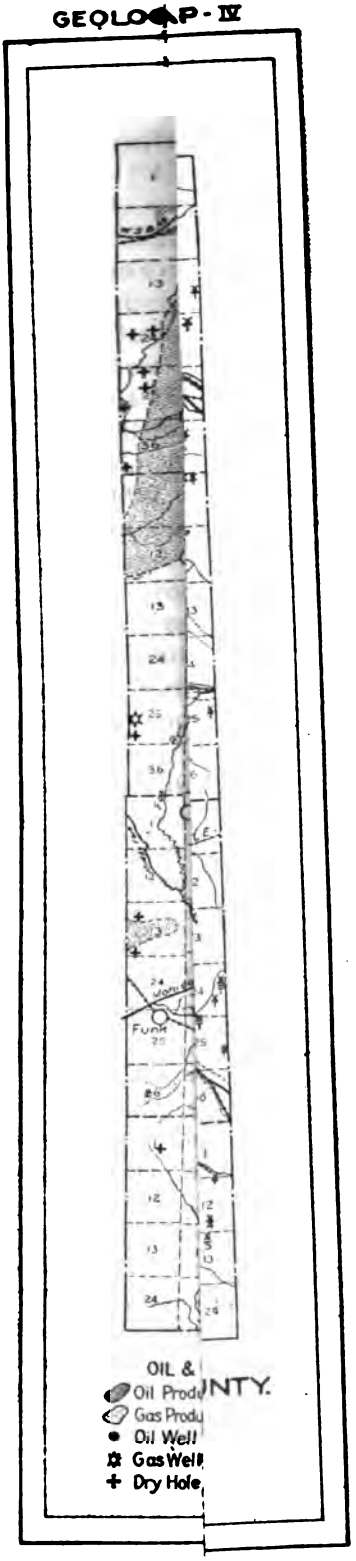
By 1910 four wells had reached the "Clinton sand."[1] In 1909 a well was drilled on the Ryland farm in Section 6, Plain Township. The "Clinton sand" was struck at 2,920 feet and had a thickness of 15 feet. The result was a flow of gas estimated at from 1,000,000 to 2,000,000 cubic feet in 24 hours and a closed or rock pressure of 650 pounds to the square inch. In the same year a second well was drilled on an adjoining farm, but the "Clinton sand" was thin and contained neither oil nor gas. Both wells showed oil in the Berea. Early in 1910 a third well was completed in Section 17, Congress Township, and gave a small production of gas. During the summer of this year the fourth well was completed on the Quimby Jones farm near where the Baltimore and Ohio railroad track crosses the Lincoln Highway. A small showing of oil and gas was obtained.

The year 1911 saw the real beginning of the development in this field. A well three quarters of a mile north of the Jones farm gave an initial production of 2,500,000 cubic feet of gas in 24 hours, but the supply diminished rapidly. On September 10, 1911, the John Rockey well in the southwest quarter of Section 21, Wooster Township, was completed with an initial production of 2,500,000 cubic feet in 24 hours and a rock pressure of 1,025 pounds to the square inch. In 1919 after almost 10 years this well was reported to have an open flow of 200,000 cubic feet per day. Encouraged by this showing a second well was drilled in the same section on the Charles Correll farm about one-half mile east and a 60-barrel oil well was secured. This discovery stimulated further drilling which developed the oil field south of Wooster.

Further drilling 2 miles southwest of Wooster in 1913 resulted in the Edward Adair well with an initial flow of 10,000,000 cubic feet of gas. Five holes were drilled on the Charles Munser farm, all of which were good producers, the smallest being 6,000,000 cubic feet in 24 hours and the largest 12,000,000. Subsequently an extensive gas field was developed to the west of Wooster.

The success in the vicinity of Wooster has stimulated drilling in all parts of the county. The results have not been so favorable everywhere, but in 1919 thirteen out of sixteen townships contained producing territory.

[1]Bownocker, J. A., Geol. Surv. of Ohio, Fourth Series Bull. 12, 1910, p. 60.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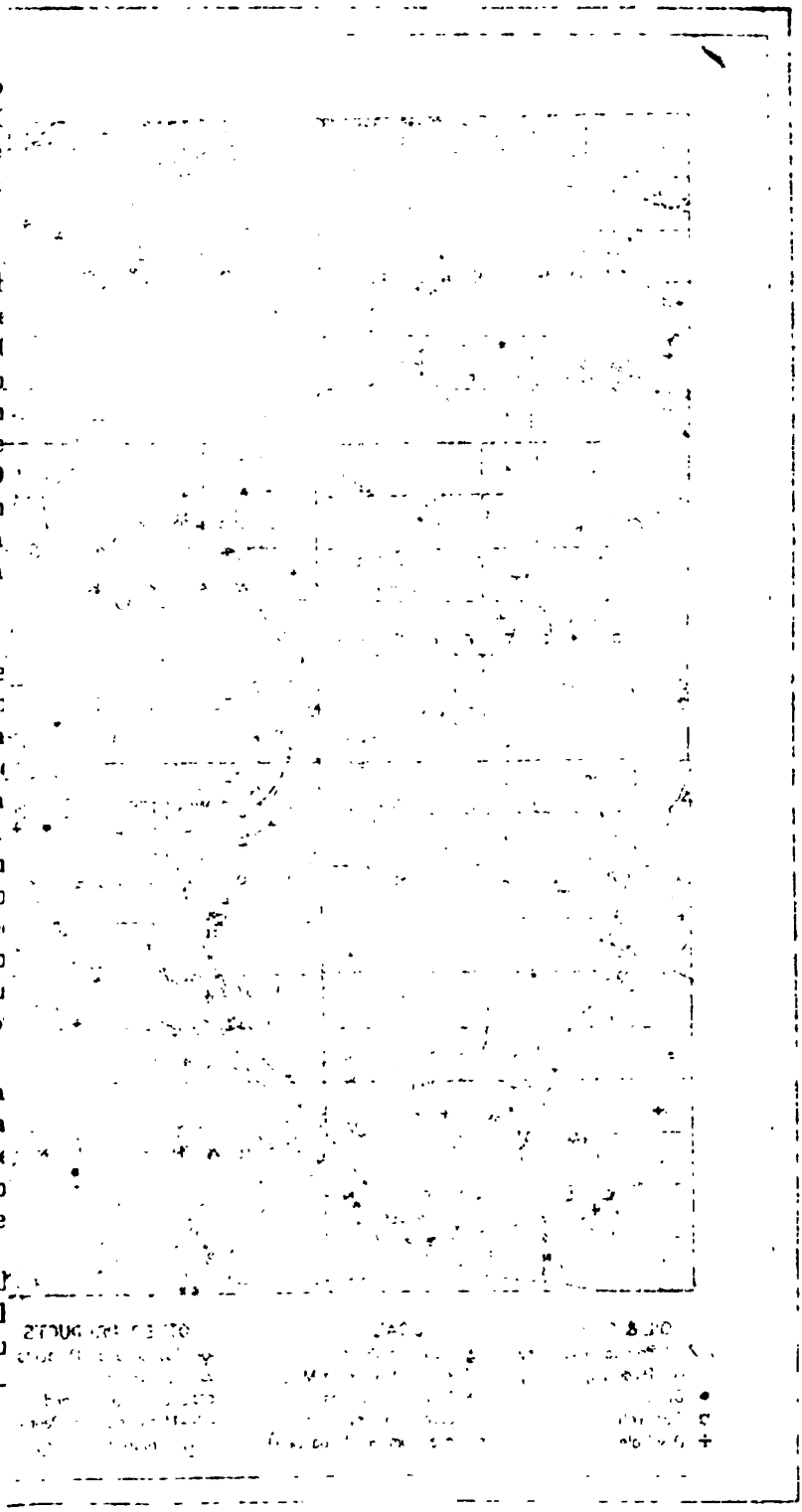

Present Development[1]

As a result of nine years of drilling more than 600 holes have been sunk to the "Clinton sand." This has resulted in the development of one oil field, one oil and gas, and four gas fields, besides a number of scattered producing wells. The largest oil well in the county is reported to have had an initial production of 250 barrels in 24 hours, while a number of wells have each made over 100 barrels. The average settled production at present is about 4 or 5 barrels. The largest initial gas flow is reported at 22,000,000 cubic feet per day for a well near Pleasant Home. The usual initial production ranges from 3,000,000 to 15,000,000 cubic feet in 24 hours, with a rock pressure between 900 and 1,200 pounds per square inch. At present wells which start as low as 500,000 cubic feet are being used.

Wooster oil field.—The only extensive oil field in the county is located south of the city of Wooster in Franklin and Wooster townships. The producing territory at present includes an area one-half to three-quarters of a mile wide and about 5½ miles long with a general northeast to southwest direction. Dry holes have been drilled on either side of this strip quite close to producing wells. Efforts to extend the field beyond Section 12, Wooster Township, have not met with much success. Drilling at the southwest end of the field in Section 33, Franklin Township, has resulted in a number of dry holes, whereas wells drilled on the northwestern border of the oil field in sections 21, 28, and 32 have produced gas.

The average initial production in this field is between 50 and 100 barrels per day. A 100-barrel well usually drops to 50 within 6 or 7 months at which it may stay for about a year, with a gradual subsequent decline. The first wells drilled in 1911 are still producing from 4 to 5 barrels a day which is about the average settled production for the field.

Shreve gas and oil field.—The producing territory, which is located east of Shreve, includes several sections in Clinton and Franklin townships just north of the county line. Recently the area has been extended to the southwest into Holmes County. In this field oil has been secured on the eastern side, while paralleling this on the west a number of gas wells have been drilled. Although located in line with the Wooster oil field, efforts to connect the two have met with failure.

Wooster gas field.—Following the completion of the Rockey well in Section 21, Wooster Township, in 1911, a rather extensive gas field has been developed to the northwest. In 1919 producing territory included an area one-half mile wide and 6 miles long in which there are about 75 producing wells. Initial production has varied from

[1]For information concerning the present development the writer is indebted to Mr. R. W. Melhorn, former geologist, and Mr. H. E. Boyd, present geologist, of the Medina Gas & Fuel Company, and to Mr. H. B. Odenkirk of Wooster.

1,000,000 to 15,000,000 cubic feet in 24 hours, and some of the early wells are still producing 200,000 cubic feet a day. A few small combined oil and gas wells have been secured.

Congress and Canaan Township gas field.—This includes by far the largest area of producing territory in the county. A large number of gas wells have been secured in the northern parts of these townships in an area extending from West Salem east to Jackson; although a large percentage of the wells occur south of Burbank, in the vicinity of Aukerman and a short distance east of West Salem. The field has been extended from Burbank south past Golden Corners into Section 17, Wayne Township. South of Golden Corners a number of oil wells have been secured. In the western part of Congress Township the gas territory can probably be extended to the southwest to include a producing area between Pleasant Home and Lattasburg. Near Pleasant Home some of the largest gas wells ever reported in the "Clinton sand" have been secured. In 1919 there were at least 190 producing wells in these townships.

In addition to the deep wells in the "Clinton sand" a few showing a small production of oil have been secured in the Berea near Burbank. One well at a depth of 480 feet showed an initial production of 6 barrels in 24 hours, which shortly diminished to 2 or 3 barrels. The difference in cost of such a well as compared with one in the "Clinton sand" can be appreciated when it is considered that the latter lies at a depth of 2,800 to 3,300 feet in this part of the county. The producing territory extends to the north into Medina County and to the west into Ashland.

Plain Township.—A number of gas wells have been secured in the eastern part of the township in an area roughly parallel with the Wooster gas field and about 2½ miles southwest of it. Another gas pool has been located in Section 13 north of Funk where there are five producing wells.

Clinton Township gas field.—In addition to the oil and gas field east of Shreve, a gas pool has been located north of Custaloga in sections 16, 17, and adjoining territory. Initial production of the wells has ranged from 4,000,000 to 15,000,000 cubic feet in 24 hours. In 1919 there were 30 producing wells. It is interesting to note that in this field the "Clinton sand" is more than 150 feet higher than in the gas wells in the eastern part of the township.

Eastern half of the county.—Outside of the main gas and oil areas in the western townships, a number of isolated wells have been secured. In the eastern half of the county, however, no extensive drilling has been undertaken. This is a result of the number of dry holes that have been secured in the eastern townships, and also of the much increased cost of completing wells, because of the greater depth to the producing sand. Whereas the "Clinton sand" is penetrated at

2,800 to 3,300 feet in Congress Township, it lies at about 3,600 feet below Chippewa Valley near Easton and at 3,800 to 4,000 feet below the surface near Mt. Eaton.

Five gas wells had been secured in Chippewa Valley, Chippewa Township, to 1919. An initial production of 5,500,000 cubic feet in 24 hours and a rock pressure of 1,340 pounds is reported for the Galehouse No. 1 well in Section 21. The total depth of this well is 3,633 feet.

Two out of three wells in the eastern part of Milton Township were dry holes, and similar results followed drilling in Green, Baughman, and Paint. These results have for the present discouraged further drilling in these townships.

Geology

The producing sand in Wayne County is the "Clinton," which is the most important gas sand in Ohio, and has also produced oil at a number of places. The following generalized section shows the relation of this formation to the overlying beds which are penetrated in drilling for oil and gas.

Generalized Section of Rocks Penetrated in Drilling for Oil and Gas

System	Formation	Driller's name	Thickness in feet
Quaternary	Glacial drift	Sand and Gravel	0–150
Mississippian	Logan Cuyahoga Sunbury shale	Shale and sandstone	400–650
	Berea sandstone	Berea Grit	5–60
	Bedford shale	Ohio shale	1135–1600
Devonian	Ohio shale		
	Delaware limestone Columbus limestone	"Big lime"	1030–1380
Silurian	Monroe formation Salina formation Niagara formation Brassfield limestone		
	Medina shales and sandstones	Includes "Little lime and Shells"	150–170
		"Clinton sand"	5–44
		Medina red rock	?

The character and thickness of the rocks as described by the driller is shown in the following well log:

M. and E. Eddy well. Section 16, Clinton Township

	Thickness Feet	To top of formation Feet
Soil	3	0
Gravel	72	3
Shale, light	250	75
Shale, light	300	325
Sand, light (Berea)	8	625
Shale, red	90	633
Shale, light	277	723
Shale, cinnamon	135	1265
Shale	30	1400
Cinnamon	220	1430
Shale	175	1650
Limestone, white ("Big lime")	1085	1825
Shale, light	30	2910
Lime, light	41	2950
Shell	11	2981
Shale	13	2992
Sand ("Clinton")	28	3005
Shale	2	3033
Total depth of well		3035

In this well, which is located in the Clinton Township gas field, the Ohio shale and Big Lime have a thickness of 1,192 and 1,085 feet respectively, while the "Clinton sand" lies about 3,000 feet from the surface.

To show the position of the "Clinton sand" and the thickness of the overlying beds in various parts of the county, the following tables have been prepared. The first table includes a number of wells in the western tier of sections in Canaan, Wayne, Wooster, and Franklin townships.

Data from logs of wells in north-south line across county

	Location	Interval surface to Berea. Feet	Berea. Feet	Ohio shale. Feet	"Big lime." Feet	Interval. Feet	"Clinton sand." Feet	Elevation top of "Clinton sand." Feet below sea level
1.	Sec. 6 Canaan	370	25	1210	1119	109	16	—1897
2.	Sec. 31 Canaan	710	45	1280	1113	118	5	—2090
3.	Sec. 7 Wayne	------	------	------	1105	117	26	—2107
4.	Sec. 6 Wooster	535	35	1306	1094	150	41	—2186
5.	Sec. 7 Franklin	610	5	1296	1009	231	33	—2266

1. James Homer No. 1 well.
2. Wm. Armstrong No. 1 well.
3. A. C. Cummings No. 1 well
4. L. D. Becker No. 1 well.
5. W. J. Wise well.

Data from wells in northern tier of townships

Location	Interval surface to Berea. Feet	Berea. Feet	Ohio shale. Feet	"Big lime." Feet	Interval. Feet	"Clinton sand." Feet	Elevation top of "Clinton sand." Feet below sea level
1. Sec. 9 Congress	625	15	1135	1095	127	14	—1881
2. Sec. 11 Canaan	425	15	1380	1188	105	14	—2125
3 Sec. 14 Milton	460	6	1519	1240	140	13	----------
4. Sec. 21 Chippewa	------	------	------	------	------	12	—2628 ± 10
5. Sec. 4 Baughman	640	50	1600	1380	150	10	----------

1. John McVicker No. 1 well.
2. C. Bowman No. 11 well.
3. F. A. Thomas well.
4. F. W. Galehouse No. 1 well.
5. P. J. Stull well.

Data from wells in southern tier of townships

Location	Interval surface to Berea. Feet	Berea. Feet	Ohio shale. Feet	"Big lime." Feet	Interval. Feet	"Clinton sand." Feet	Elevation top of "Clinton sand." Feet below sea level
1. Sec. 16 Clinton	625	8	1192	1085	95	28	—2016
2. Sec. 13 Clinton	530	15	1295	1104	113	44	—2189
3. Sec. 18 Franklin	515	30	1285	1060	184	39	—2229
4. Sec. 3 Paint	775	25	1490	1365	190	30	—2837 ± 20

1. M. and E. Eddy well.
2. Ellen Bevens No. 1 well.
3. Samuel Fair No. 2 well.
4. S. P. Beats well.

The distance between the first and last well in each series is 19½, 19, and 18½ miles respectively.

From these well records it may be seen that not only does the depth to the "Clinton sand" increase to the eastward as a result of the normal dip, but also because of the increasing thickness of the Ohio shales and "Big lime." The rate of increase will be taken up in detail under the discussion which follows of the various formations.

As a result of drilling for oil and gas, not only has the total thickness of the formations been determined, but also much has been learned

of the lithology of the rocks. Some of the more important characteristics will be given.

Medina red rock.—The oldest rock reached in the Wayne County field is called the Medina red rock by the drillers and consists of a reddish clay shale with beds of gray, purple, and black color. Not much is known of its character and thickness as drilling is stopped when these beds are penetrated.

"Clinton sand."—The "Clinton sand" which is the oil and gas-bearing rock is a gray sandstone, but occasionally a red color is reported. The thickness varies from a few feet to as much as 44; however, a few wells have reported no sand at all at this horizon. As is the case elsewhere in the State the "Clinton" is reported to be without water except in a few instances where it probably leaked in through the casing.

The depth to the "Clinton sand" varies from 3,000 feet near Burbank to 4,000 in the vicinity of Mt. Eaton in the southeastern corner of the county. This increased depth results from two factors: first, the natural dip of the beds toward the southeast and, second, the thickening to the east of the Ohio shale and "Big lime." Across the northern part of the county this increase in thickness for the Ohio shale is about 24 feet to the mile, whereas for the "Big lime" it is about 15 feet. The elevation of the upper surface of the "Clinton sand" drops at a rate of about 44.5 feet to the mile.

It has been shown by Bownocker[1] that the term "Clinton sand" is a misnomer in that the sand does not occur in the Clinton formation but rather lies below it and forms part of the Medina. Westward the "Clinton sand" thins and beyond the longitude of central Ohio its place is taken by shales.

Interval between the "Clinton sand" and 'Big Lime."—This interval of 150 to 170 feet is largely occupied by dark gray shales. Hard calcareous layers—the "shells" of the driller—occur in places about 40 to 60 feet above the "Clinton sand." One or more "stray sands," which occasionally have been oil-bearing, are sometimes reported within this interval. These beds are thought to be in part at least of Medina age.

"Big Lime."—The term "Big lime" is applied by the driller to the great thickness of limestone which occurs everywhere in the field under the Ohio shale. It includes gray, blue, and brown limestone, whose composition in the middle portion corresponds to dolomite, while the upper and lower portions are low in magnesium. Layers of brown calcareous shale are reported near the top, and near the base there frequently are thin shales and occasionally a sandstone bed. In one instance at least a stratum in the "Big lime" has produced oil. Beds of salt 40 to 80 feet thick and lying about 600 feet below the top

[1]Bownocker, J. A., Economic Geology, Vol. 6, p. 49.

of this rock have been encountered as far south as Mt. Eaton. Water occurs in rather large quantities in some parts of the "Big lime."

The thickness of the "Big lime" varies from 1,030 feet in the western part of the county to 1,380 feet to the east, and shows a gradual thickening. Near Mansfield the thickness is reported to be 915 feet, while a well recently completed near New Alexandria, Columbiana County, showed 1,987 feet. In a north and south direction there is no great change in thickness; in fact some wells in the southern part of the county showed a slightly decreased thickness from that reported along the north county line. The "Big lime" includes the Silurian and Devonian limestones which are known at their outcrops in western Ohio as the Brassfield, Niagara, Monroe, Columbus, and Delaware. It includes also the Salina formation, but this is wedge-shaped with the apex to the west and the rocks nowhere outcrop in Ohio.

Ohio shale.—Overlying the "Big lime" is a great thickness of shale varying in color from black to brown, red, and gray which is known to the driller as the Ohio shale. It varies in thickness from 1,135 to 1,600 feet, and shows a steady expansion to the east. In the Mansfield well a thickness of 700 feet was reported and at New Alexandria, Columbiana County, to the east it is 2,701. As has already been pointed out, the rate of thickening of the Ohio shale is much greater than that of the "Big lime." In a north-south direction there is no regular variation, the thickness at Wooster being slightly greater than at either the north or south boundary of the county.

The Ohio shale of the driller includes the Ohio and Bedford shales, the former of Devonian age, the latter, Mississippian.

Berea grit.—The Berea sandstone (grit) is one of the best known horizon markers in eastern Ohio. Although seldom 75 feet in thickness, it is a very persistent formation and is used by oil men as a key rock for drilling over a large area. This formation has been one of the most important oil and gas sands in eastern Ohio, but in Wayne County it has never been found to contain either in paying quantities. A short distance north of the county near Chatham, an oil pool has recently been opened in this rock. A few wells in the Berea near Burbank have given about 5 barrels each of oil, but production soon diminished.

The Berea sandstone is a medium-grained gray rock, and in Wayne County its thickness varies from 20 to 60 feet.

Formations over the Berea.—Overlying the Berea sandstone there is a succession of black, blue, and gray shales and gray sandstone of Mississippian age, which the driller usually describes as shales. The total thickness of the rocks overlying the Berea, including the covering of glacial drift, varies from 370 feet in the lowland near Burbank to 775 feet near Mt. Eaton. In the latter case some Pennsylvanian rocks are included as well as the upper part of the Mississippian.

Structure.—It is very generally thought that accumulations of oil and gas are associated with certain forms of structure in the rocks such as anticlines, arrested monoclines, and so forth. Because of the heavy cover of glacial drift and the consequent lack of exposures of the surface rocks it is practically impossible to observe whether or not the surface rocks show any folding.

From a study of well logs and the measurement of the elevation of well heads, Bonine[1] has determined the structure in the "Clinton sand" in the oil field south of Wooster, also in the gas field west of the city. Concerning the former he says "the structure contours in the oil field show several irregular folds in which oil has accumulated and a small but higher structural terrace along the western edge of the field where gas has collected."

Concerning the gas field he reports "the principal structural feature of the gas field . . . . is a sharply pitching anticline west and southwest of Wooster, along the crest and sides of which the gas has accumulated. The narrowness of the gas producing area is due to the sharpness of this fold, and the presence of dry holes in close proximity to large gas wells is also partly explained by this fact."

In the case of the oil field the fold is roughly parallel to the strike of the rocks of the region—south by southwest. The presence of folds at approximately right angles to this direction, as in the gas field, seems to indicate that the rocks had been subjected to at least two sets of forces great enough to cause gentle folding and, moreover, that these forces had operated in different directions. The presence of such folds transverse to the usual direction may be expected in other parts of this region.

COAL

Coal of minable thickness occurs in the eastern and southeastern townships, where it is confined very largely to the area within 3 miles of the county line. Railroad shipping mines have been operated in Chippewa, Baughman, Sugar Creek, and Paint townships, where the Sharon or No. 1 coal is developed. In Franklin, Salt Creek, and Paint townships, wagon mines have supplied the local demand. The coal beds vary in thickness from 2 to 7 feet, the latter figure being the maximum for the Sharon which averages about 5 feet. Other coal beds including the Middle Mercer, Bedford, Tionesta, Brookville, and Lower Kittanning seldom exceed 3 feet and average less than 2 feet 6 inches. All of the coals are more or less irregular in their development and subject to considerable variation in thickness within short distances, which makes mining uncertain, unless the territory is thor-

[1]Bonine, C. A., Anticlines in the Clinton Sand near Wooster, Wayne County, Ohio, U. S. Geol. Survey Bull. 621-H, 1915, pp. 195-96.

oughly tested with the drill. The only coal that has occurred in any quantity is the Sharon and it has been very largely worked out. Only one shipping mine was in operation in the county in 1919. The quality varies from fair to excellent, and the chief use is for domestic purposes.

Of the coal beds of the county only three are being worked at present—the Sharon or No. 1, the Brookville or No. 4, and Lower Kittanning or No. 5. In former years the Middle Mercer, Bedford, and Tionesta coals were mined in a small way.

Sharon or No. 1 coal

The Sharon or No. 1 coal, which is the lowest in Ohio, has its best development in Stark and adjacent parts of Summit, Medina, and Wayne counties. The field is called the Massillon and the coal is known in the market as the Massillon Block.

This bed throughout its occurrence in the Massillon coal field is characterized by a very patchy nature. The coal occurs in basins or pockets, which vary in size from 5 to 300 acres. It is at its best, both in quality and thickness, near the center of the basins, and deteriorates as it thins toward the margins. Large masses of rock, known as horsebacks, in places occur in the basins and cut out the coal. The irregularity of the bed makes mining uncertain.

In Wayne County this coal has been mined in each of the four eastern townships, of which Chippewa has been by far the largest producer.

Chippewa Township.—The Sharon coal occurs in considerable thickness over about a third of this township. North of Chippewa Valley it is confined to the area east of Doylestown, also sections 3 and 15. To the south it has been mined in sections 25, 26, 35, and 36. Adjacent to the valley the coal is secured in either drift mines or slopes, whereas on the upland the shafts vary from 100 to 150 feet in depth.

This coal was first mined in the county a short distance south of Doylestown. The fact that it outcrops along the valley walls of Chippewa Creek in the eastern part of the township probably led to its discovery at a very early date. In 1884 Orton[1] reported that "a large acreage has already been worked out in Chippewa Township and no basins of large size remain unattacked." At that time the Woods mine in Section 15 had been in operation more than 40 years, and the Old Chippewa mine in Section 16 had been exhausted. Between 15 and 20 mines of considerable size have been operated in the township at various times, a number of which have had a production of over 100 tons a day while in a few cases it has been as much as 200 to 250 tons. Cleveland was the principal market and the "Blue Chippewa coal" set the standard.

[1]Orton, Edward, Geol. Surv. of Ohio, Vol. 5, 1884, p. 789.

The only mine of any importance in operation in this township at present is located in Section 12 and is known as the Elm Run or No. 10. This is an old mine which was reopened in 1916 after having been closed for many years. The coal is reached by shaft, 142 feet deep, and has a thickness of 4½ to 5 feet. It shows an unusual development in that in places it is in two benches separated by 2 feet of gray sandstone. The coal is transported by wagon or truck as the railroad spur shown on the topographic map has long since been removed. It is used largely for domestic purposes.

The No. 1 coal is being mined by slope or drift in a small way for local use at a number of places in the township where small deposits or remnants left from former mining are being removed.

Baughman Township.—In this township the Sharon coal is confined to a belt about one-half mile wide along the western county line and to several small areas in the vicinity of Burton City. Coal was first mined in this township at an early date. One of the most important mines was the Fox Lake in the northeastern quarter of Section 12, which has been described by Orton[1] in considerable detail in his report on the Massillon coal field. In 1883 the production was 250 tons a day. After having been closed for 35 years, the mine was reopened in 1919 through an old air shaft. At this place the coal lies about 50 feet below the surface, and has a thickness of 5 to 7 feet. Orton[2] gives the following analysis for the coal from this mine:

Coal analysis of Fox Lake Mine, whole seam (Lord)

Moisture	5.92
Volatile combustible matter	37.72
Fixed carbon	53.74
Ash	2.62
Total	100.00
Sulfur	.68

An analysis of the lower 3 feet showed a slightly lower ash—1.67 per cent with sulfur content still very low—0.86 per cent. These analyses show the coal to be very low in ash and sulfur and high in fixed carbon—a first class bituminous coal.

No other mines are in operation in the township at the present time. Burton City (Fairfield of the early day) was the site of coal mining between 1875 and 1885, there being small bodies of coal on both sides of the valley just west of the village. Two other mines have been operated on the south side of the valley east of Burton City.

[1]Orton, Edward, Geol. Surv. of Ohio, Vol. 5, 1884, pp. 792-796.
[2]Idem., p. 793.

That there should be so small an area of Sharon coal in this township has been a cause of surprise. A little east of the central part of the township there is a deep valley of erosion now filled with glacial drift in which the rock floor over a large area lies more than 200 feet below the present surface. A result of these conditions is that the coal is confined to the southern part of the township and to a narrow belt along the county line.

Sugar Creek Township.—This township ranks next to Chippewa in the total area underlain by the Sharon coal. It has been mined at a number of places in the vicinity of Dalton, also in sections 24 and 25. Near Dalton the coal occurs everywhere at a depth of over 100 feet below the surface, and was not located until a comparatively recent date.

At Burton City the coal bed lies above the level of the valley floor, while at Dalton, 3 miles south, it is from 125 to 150 feet below the surface even in the lowlands and had to be mined by shafts. Operations of the Massillon Coal Company began near Dalton about 1910 and four large mines have been operated at various times since that date. One mine north and another east of the village have been worked out. At the third mine to the southeast the tipple burned and was never rebuilt. When in operation it was producing about 240 tons a day. The fourth mine, located 1 mile south of Dalton, started operation in 1914 and was closed in 1917 following trouble with quicksand, of which there is reported to be about 100 feet in the valley. The coal bed lies at a depth of 150 feet. A considerable body of coal is reported under this valley, but the cover makes mining difficult.

The largest mine in the county is located in the northeast corner of Section 24, Sugar Creek Township. In the Oak Hill mine, as it is called, the coal is reached by means of a shaft 232 feet deep. The coal averages about 5 feet 6 inches in thickness and is mined by electric cutting machines. Considerable trouble has been encountered in mining because of "horsebacks" of sandstone which cut out the coal. This mine is operated by the Oak Hill Coal Company of which C. H. Albright of Massillon is president. The production is placed at 100 tons a day, and a spur from the Wheeling & Lake Erie Railroad furnishes an outlet. In 1919 this was the only railroad shipping mine in the county.

Two other rather large mines have been operated in this same section. In the fall of 1920 a slope was being put down along the south section line to take out a body of coal lying in the northwest part of Section 21. A railroad spur has been constructed to the mine. Production will be about 50 tons a day. Several other mines have been operated within the last 5 years around the borders of the upland in Section 25. To the west of this section the coal is either thin or wanting.

Paint Township.—The Sharon coal has been mined in two sections in this township. At least two shaft mines have been operated in Section 1, where the coal is reported to lie 50 feet below the surface in North Fork Valley. On the south side of this valley a slope was constructed to remove a small body of coal from the north central part of Section 12. Outside of this limited area the coal is either lacking or too thin to make profitable mining. At present no mining of the No. 1 coal is being done in the township.

As to the quality of the Sharon or No. 1 coal the following statements by Bownocker[1] concerning the Massillon field as a whole are very applicable to the portion in Wayne County: "The bed differs from other coal beds of Ohio in being without persistent partings. Some pyrite is present, especially along the borders of the basins or where horsebacks occur. Nevertheless the coal is unusually free from impurities, greatly enhancing the esteem in which it has always been held. The bed in greatest thickness measures 4½ to 5 feet, but it changes sharply and may pinch out in a short distance. . . . The changes are due to unevenness in both roof and floor, but perhaps most commonly to those in the roof. In places the floor is notably uneven, and the coal may lie on a low swell instead of a flat surface. Shale commonly forms the roof and clay the floor, but in places sandstone forms one or both.

"The coal is open burning (that is, it does not fuse during combustion), lustrous, produces a good portion of lump, and stands transportation well. Films of calcium carbonate known as "white-cap" are common on the surface of the coal and give it a spotted appearance. The coal along the western margin of the field, although good, is not quite up to the highest standard of the bed. The great use of the coal has always been for domestic purposes. It is clean, ignites easily, makes a hot fire, and produces little ash. It contains an average of about 53½ per cent of fixed carbon, 37 per cent of volatile matter, 5½ per cent of moisture, and 4 per cent of ash. . . . . Cleveland has always been the principal market for the coal."

Middle Mercer, Bedford, and Tionesta coals

These coal beds are either thin or wanting over much of the area where due, but locally they have had a sufficient thickness to warrant mining. The Middle Mercer coal is not known to have been mined in the county. The Bedford coal which underlies the Upper Mercer or blue limestone has been mined in sections 4 and 8, Salt Creek Township, where the thickness is reported 5 feet 9 inches with two shale partings.[2] The middle bench, 3 feet 5 inches thick, was of very fair quality.

[1]Bownocker, J. A., The Coal Fields of Ohio, U. S. Geol. Survey, P. P. 100-B, 1917, p. 38.

[2]Read, M. C., Geol. Surv. of Ohio, Vol. 3, 1878, p. 535.

The Tionesta or No. 3 coal appears to be very unsteady and frequently is not present where due. Small mines have been operated in Section 13, Salt Creek Township, also in Section 10, Paint Township, a short distance northwest of Mt. Eaton.

At the present time no coal is being mined at any of these horizons and for the most part they are of comparatively little economic value.

The Brookville or No. 4 coal

The Brookville coal is second in importance in the county, but is far behind the Sharon both in thickness and in quality. It occurs in minable thickness in the southern half of Paint, Salt Creek, and Franklin townships. The coal has been mined at a number of places in the vicinity of Mt. Eaton where it occurs near the hilltops. The thickness at these places varies from 2 feet to 2 feet 6 inches. Occurring as it does beneath the Putnam Hill or gray limestone it has been used for burning lime in addition to its use for domestic purposes, but at the present time it is not being mined in the township. In Salt Creek Township the coal has been mined extensively in Section 23 on the Stutz farm where it had a thickness of 2 feet 4 inches to 2 feet 6 inches with a 3-inch clay parting 6 inches from the top.

At the present time the Brookville coal is being mined at two places in Franklin Township. In the south part of Section 24 the Cherry Valley Coal Company is removing the coal and the underlying fire clay for use in its brick works located just south of the county line in Salt Creek Valley. A second small mine is being operated at the southern end of Sterrett Knob in Section 22. In both the coal has a thickness of about 3 feet which is a little greater than has been reported in the townships to the east.

The quality of the coal is fair and the sulfur content is moderate. The chief uses are for domestic purposes, steam coal, also for burning brick and lime. The total quantity mined at present is small.

The Lower Kittanning or No. 5 coal

This coal occurs in minable thickness in Paint Township near Mt. Eaton where it outcrops near the summits of the higher hills. It is the coal identified by Read[1] as the No. 7 coal of which he says, "it occurs in the top of the hill at Mt. Eaton without cover, where it was formerly mined to a small extent by drifting and most of it apparently removed." This probably refers to a deposit just north of the village which was mined in an early day. Southeast of Mt. Eaton the No. 5 coal has been mined by drifting, also by shafting. One of the latter ceased operations as recently as 1917. The thickness is reported as 3

[1]Read, M. C., Geol. Surv. of Ohio, Vol. III, 1878, p. 534.

feet to 3 feet 8 inches which is slightly greater than the thickness of the Brookville coal. Two other mines have been operated in Section 21.

In 1919 the No. 5 coal was being mined in the north central part of Section 13 where the bed has a thickness of 2 feet 8 inches. As is the case elsewhere, the coal has a shale roof. From this mine it is being hauled by truck to Brewster. It is reported to be of very fair quality although rather high in sulfur.

CLAY AND SHALE

The clay and shale deposits of the county furnish the raw material for the manufacture of paving and building brick, tile, and stoneware. The chief formations which have been used for this purpose are the shales of the Black Hand member of the Cuyahoga formation and the clays underlying the coals of the Pennsylvanian. Glacial clays cover the surface of the county, but, because of their stony character, they have been used to a very limited extent. The most important clay-using industries are located near Wooster, Fredericksburg, and Dalton.

Shales of Black Hand member

These shales, which outcrop at numerous places along Killbuck Valley to the northwest of Wooster, are utilized for brick making about 1 mile northwest of this city where is located the plant of the Medal Paving Brick Company. The shale pit, from which the raw material is obtained, is situated east of the highway about a quarter of a mile from the plant. In this pit the working face is 40 to 50 feet. The overburden which has to be removed includes 15 to 22 feet of sandstone and 3 to 5 feet of glacial drift. About 5 feet of sandstone is blown down with the shale and separated in handling. In addition to the shale exposed, drilling has shown that there is about 20 feet additional shale available below the base of the present quarry. The shale is bluish-gray in color and of excellent quality for paving brick. Layers of nodular iron concretions occur in some parts of the shale and have to be removed where too numerous. A detailed section measured in this pit is given on page 62. In 1919 this plant had been in operation 18 years, having been taken over by the present company in January 1916. The product at present is very largely paving block, approximately 15 per cent being standard brick which is used for building and sewer construction. Normal production is about 4,500 tons a month.

Pennsylvanian clays

Throughout the eastern and southern parts of the county the clays which commonly underlie the coal beds furnish raw material for

various clay products. These vary in thickness from 3 to 8 feet, are usually gray in color, low in iron, and vary from slightly siliceous to plastic.

The clay under the Upper Mercer limestone and Bedford coal is being utilized by E. Houghton & Co. of Dalton in the manufacture of stoneware of many kinds. This concern has been operating since 1842 and is probably one of the oldest plants in continuous operation in the State. Between 400 and 500 tons of clay are worked up into stoneware each year. When in full operation 12 men are employed.

The raw material is hauled from about 1 mile southwest of Dalton in the SW. ¼ NE. ¼ of Section 9, Sugar Creek Township. The following section shows the succession of beds at this locality:

		Feet	Inches
4.	Limestone (flint) *Upper Mercer*	1 to 1	8
3.	Coal, *Bedford*, unsteady, average	1	--
2.	Clay, siliceous, upper part gray, lower part dark	8	--
1.	Sandstone.		

Before being used the clay, which is secured by stripping, is spread out in a heap and allowed to weather for several months. It is reported to be of excellent quality for stoneware.

A sample of this clay collected by Mr. Wilber Stout and analyzed by Prof. D. J. Demorest in connection with a forthcoming report on the clays of Ohio gave the following result:

Analysis by Prof. D. J. Demorest of Clay used by E. Houghton & Co., Dalton

	Per cent
Moisture at 105°	1.82
Ignition loss	6.86
Silica, SiO_2	60.41
Alumina, Al_2O_3	23.71
Ferric oxide, Fe_2O_3	1.93
Titanic oxide, TiO_2	1.05
Lime, CaO	.22
Magnesia, MgO	.50
Sodium oxide, Na_2O	.16
Potassium oxide, K_2O	2.84
Phosphorus pentoxide, P_2O_5	.02
Manganese oxide, MnO	.02
Sulfur, S	.04
Inorganic carbon	.09
Total carbon	.19

The analysis shows this to be a second-grade fire clay, very well suited for stoneware, fire proofing, and building brick. The low content of sulfur is to be noted, and is especially favorable for stoneware.

The clay under the Brookville or No. 4 coal is being utilized for brick making near Fredericksburg by the Mount Cherry Coal Company. The plant is located a short distance south of the county line in Holmes County, but the mine from which the clay is secured is located in the southern part of Section 24, Franklin Township. Both coal and clay are being removed by means of a drift in the hillside. The following section shows the relation of the beds:

Section of the mine of the Mount Cherry Coal Company, Section 24, Franklin Township

		Feet	Inches
4.	Limestone, gray, *Putnam Hill*	4	--
3.	Shale, dark, fossiliferous	--	3
2.	Coal, *Brookville or No. 4*	3	--
1.	Clay, gray, siliceous	6	--

The clay is free from concretionary matter and is not micaceous. Its composition is shown by the following analysis of a sample collected by Mr. Wilber Stout and analyzed by Prof. D. J. Demorest:

Analysis by Prof. D. J. Demorest of Brookville clay from the mine of the Mount Cherry Coal Company near Fredericksburg

	Percent
Moisture at 105°	2.09
Ignition loss	10.13
Silica, SiO_2	51.31
Alumina, Al_2O_3	28.39
Ferric oxide, Fe_2O_3	2.95
Titanic oxide, TiO_2	2.01
Lime, CaO	.38
Magnesia, MgO	.60
Sodium oxide, Na_2O	.28
Potassium oxide, K_2O	1.78
Phosphorus pentoxide, P_2O_5	.01
Manganese oxide, MnO	.01
Sulfur, S	1.00
Inorganic carbon	.00
Total carbon	.75

Pennsylvanian clays have been utilized in the past by small brick and tile factories at a number of places in the county. One such plant, which only recently ceased operations, was located about one-half mile north of Marysville in Salt Creek Township, where local surface clays were mixed with other clay.

Surface Clays

Surface clays of such character to be of use for the manufacture of clay products are confined to some of the larger valleys where there are slack water deposits. The glacial drift, where argillaceous, ordinarily contains a sufficient quantity of sandstone fragments to render it of little value. Surface clays are being used one and one-half miles southwest of Orrville in Section 35, Green Township, by the Ohio Farmers Clay Company in the manufacture of drain tile and hollow ware for building purposes. The deposits, which vary from 5 to 25 feet in thickness, are of slack water origin, and are underlain by fine sand. Because of the height of the water table, only 5 or 6 feet is being utilized. The working face of the deposit shows the following variations:

Section of the clay pit of the Ohio Farmers Clay Company, Orrville

		Feet	Inches
3.	Clay, black	1	6
2.	Clay, gray, streaked with yellow	2	6
1.	Clay, yellow	2	6

By mixing the various layers in the proper proportions the clay burns to a cherry red and gives a tile of excellent quality. Three kilns are being operated.

Elsewhere in the county these clays have formed the basis for small industries in the past. The tile factory north of Marysville has already been mentioned. The brick factory near Wooster when first started made use of a small deposit of surface clay a short distance southwest of the present plant. A tile factory was at one time operated about 1 mile north of Craigton in Plain Township. Such deposits are for the most part very limited.

SALT

In the production of salt Ohio ranks second only to Michigan and New York. This industry dates back to the pioneer days of the early part of the nineteenth century.[1] Prior to 1889 it was confined to southeastern Ohio where the brines from which the salt was refined were pumped from wells varying in depth from 300 to 1,500 feet.

The development of the industry in northeastern Ohio began about 1889 at Newberg and since then has been extended to Cleveland, Kenmore, Wadsworth, and Rittman, the last located in Wayne County.

[1]Bownocker, J. A., Salt Deposits and Salt Industry in Ohio, Geol. Surv. of Ohio, Fourth Series, Bull. No. 8, 1906, pp. 9, 32.

History of development at Rittman

The plant of the Ohio Salt Company is located at Rittman in the northeastern part of Wayne County. The company was incorporated in 1898, with capital stock of $250,000 and began manufacturing salt in the autumn of the same year. For the first year the average daily production was 600 barrels, but the capacity of the plant has been increased from time to time until in 1919 it had reached 5,000 barrels a day.

Salt Manufacture

At the present time the company has five operating wells the depths of which average approximately 2,600 feet.[1] The rock salt is dissolved in fresh water secured from wells varying in depth from 70 to 120 feet. The water is pumped into the wells by 6 phase, 8 inch centrifugal pumps, with a surface pressure of 500 pounds per square inch, and the brine which is about 99 per cent saturated is forced up through a 3½ inch pipe and stored in large cisterns till required for evaporation.

Grainers and vacuum pans are used for evaporating the brines. The former, of which there are sixteen, are rectangular concrete vats 120 by 10 by 2 feet. The brines are heated by exhaust steam, through coils made of 3½ inch steel pipes. Ten of the grainers are provided with self-rakes, consisting of two endless chains, one on each side of the grainer to which are attached transverse iron strips which draw the salt out as fast as it accumulates on the bottom of the pans. The salt is called "Medium" and is light and flaky.

Six grainers without self-rakes are used for the production of a coarse salt known as "Ground Alum." The evaporation is carried on at a fairly low temperature and the salt is allowed to remain undisturbed. It is removed by hand in order to preserve the grain.

Although concrete vats were being used in 1919, they had not proved to be entirely satisfactory, and were being replaced by steel ones which do not rust when they are kept filled with brine.

Gypsum, which is the principal impurity in the brine, is deposited on the heating coils as a crust and has to be removed about once a week.

The vacuum pan equipment consists of two single effect pans, each 10 feet in diameter, also three others operated as a triple effect. The latter are 18, 20, and 22 feet in diameter and 52 feet high, and contain 5,365, 5,775 and 6,300 square feet of heating area respectively. In the single effect system a vacuum of about 25 inches is maintained, while in the triple effect the vacuum is 18 and 23 inches in the first

[1]For information concerning the manufacture of salt the writer is indebted to Mr. Devane Walker, Asst. General Manager of the Ohio Salt Company, also to Mr. C. R. Parkinson, Chemist.

two and about one inch less than barometric pressure in the third. The vacuum is maintained by air pump and by condensation in the pans of both exhaust and live steam.

The salt produced in the vacuum process is known as "Common Fine." It collects at the bottom of the pans and is removed by elevators to electric cars which carry it to the warehouse, where it is stored for 5 to 8 weeks to air dry. Centrifugal driers are being installed which will shorten the time of this process very materially. The salt is marketed in bags, barrels, and carload lots without further treatment.

If special brands are to be prepared the salt is further dried in steam heated rotary driers of which there are five, each 60 feet long by 5 feet in diameter. After drying the salt is screened to remove lumps and to separate it into different sized grades, and is then packed in bags and boxes.

"Common Fine" salt, after being dried and screened, is known as table and dairy salt. "Prepared" or "Free Running" salt is made by adding about 1 per cent of magnesium carbonate. "Medium" or "grainer salt" is screened to give coarse, meat, cheese, and butter salt.

The refined product is utilized for packing house purposes, butter and cheese, refrigeration, ice cream making, and for table uses, but by far the largest use is in the packing industry. The salt is sold as the Chippewa brand under the slogan—"Look for the Indian."

The company manufactures its own bags, and also has a large cooperage. Boxes are made at a factory near by. For printing the labels on the various containers a two-color printing press is used.

Potassium chlorate, which is also produced by this company, is manufactured by means of the electrolytic process. Muriate of potassium, which is the raw material, is shipped to the plant from various sources. The exhaust steam from the engines used in developing the electric current for the chemical plant is employed in evaporating salt brines. Potassium chlorate is used in the manufacture of matches.

Geology of the salt deposits

The rock salt is obtained in the Salina formation at a depth of about 2,600 feet. The beds, which are of Silurian age and occur between the Niagara and Monroe formations, are wedge-shaped with the apex to the west and nowhere outcrop in Ohio. The following well records reported by Dr. Bownocker show the succession of beds:[1]

[1]Bownocker, J. A., Salt Deposits and the Salt Industry in Ohio, Geol. Surv. of Ohio, Fourth Series, Bull. No. 8, 1906, p. 32.

Well No. 1

		Feet
Clay		40
Quicksand and gravel		133
Gray sandstone (Berea)		20
Bedford and Ohio shale	Black shale	1,007
	Red shale	50
	Slate and shells	250
	Brown shale	535
Corniferous and Monroe formations	Limestone	268
	Gray sandstone	30
	Shelly limestone	225
Salina formation	Rock-salt	66
Total		2,624

The succession within the Salina formation is shown by the following record:

Well No. 3

		Feet
Drift		171
Cased out fresh water at		240
Struck mineral water at		2,272
Cased this out at		2,324
Salina formation	Rock-salt at 2,513 feet	6
	Limestone	25
	Rock-salt	30
	Limestone	5
	Rock-salt	35
	White slate	30
	Limestone	7
	Total depth	2,651

Sufficient salt has been removed from some of the wells so that underground connections have been established between them.

Although the salt producing area at the present time is limited to four counties the beds are known to have a much wider distribution. They have been reported to the eastward near Cortland in Trumbull County at a depth of 3,239 to 3,710 feet and also near New Alexandria, Columbiana County, between 4,232 and 4,754 feet. Near Cleveland the Salina formation is reported to occur at a depth of 1,821 to 1,952 feet. The salt beds do not extend as far west as Sandusky.

The southern limit of the deposits is not definitely known, but the Wayne-Holmes county line marks in a general way the southern boundary. Recently rock salt was penetrated in drilling for oil in southeastern Wayne County near Mt. Eaton where 80 feet was reported at a depth of 3,220 feet. Similar beds were found in the wells near Bolivar,

Tuscarawas County. Salt beds have not been definitely reported in Holmes County and the same holds from there south to the Ohio River, including the great oil and gas region of central Ohio.

Chemical composition of the salt

The composition of the brine as pumped from the well is shown by the following analysis furnished by Mr. C. A. Parkinson, chemist of the Ohio Salt Company:

Specific gravity	1.202	
$CaSO_4$	5.55	grams per liter of brine
$CaCl_2$	0.47	
$MgCl_2$	0.20	
$Ca(HCO_3)_2$	0.19	
NaCl	303.40	

The chief impurity is calcium sulfate. Magnesium salts are low.

The various grades of salt put on the market show the following composition[1]

	$CaSO_4$ %	Na_2SO_4 %	NaCl %
1. Ground Alum	1.57	0.03	98.40
2. Medium Grainer	1.09	0.11	98.80
3. Common fine	1.21	0.05	98.74
4. Dairy	1.18	0.11	98.72
5. Prepared	0.208	None	99.79

The uniform high purity of the various products is to be noted.

Bittern waters in large quantity are encountered in the wells at a depth of about 1,500 feet. The following analysis, supplied by Mr. Parkinson, shows their composition:

Bittern water from New Well No. 1

Specific gravity	1.164	
$CaSO_4$	0.79	grams per liter of brine
$CaCl_2$	74.00	
$MgBr_2$	1.55	
$MgCl_2$	23.15	
NaCl	131.60	

At the present time these natural brines are not utilized, but the possibilities of securing bromine and other materials from them are under consideration.

[1]Analyses furnished by Mr. C. R. Parkinson, Chemist of the Ohio Salt Company.

MOLDING SANDS

Sands for molding purposes require a high refractory nature and the principal ingredient is quartz. The presence of other minerals tends to lower the refractory nature of the sand since they liquify at lower temperatures. The following figures show the melting point of some of the more common minerals:[1]

Quartz (silica)	2,912°F.
Plagioclase (anorthite)	2,790
Orthoclase	2,246
Hematite	2,372±
Magnetite	2,300±
Muscovite	1,230

One of the great sources of molding sand in Ohio is the Sharon conglomerate or coarse sandstone which occurs at the base of the Pennsylvanian or "Coal Measures," and which outcrops over a large area in northeastern Ohio. In Wayne County it is exposed in the northeastern township along the walls of Chippewa Valley.

The Sharon conglomerate in Wayne County is a coarse-grained gray sandstone some of whose beds are quite pebbly, but it has lost much of the conglomeratic nature so characteristic farther north in the State. Because of its high quartz content it can be utilized as a molding sand for steel purposes.

At present two companies are quarrying the Sharon conglomerate: The Franklin Industrial Company of Massillon is operating a crusher in the west central part of Section 25, Chippewa Township. This plant has been in operation for about 20 years, but not all of that time by the present company. About 50 feet of the coarse conglomerate sandstone is being quarried. (For a section in this quarry see page 93.) No sorting of the rock is attempted, all being sent to the crusher. The output of the plant varies from 15,000 to 40,000 tons a year, and the product is used for steel molding and for traction sand.

A second plant is being operated about one-half mile farther east by the Oliver Silica Sand Company and has been in operation for 15 years. The working face is about 50 feet high and the character of the rock is quite similar to that already described for the other quarry. The rock is crushed without sorting and it is used largely for steel molding sand in the Pittsburgh district.

The composition of the molding sand produced by the Franklin Industrial Company is shown by the following analysis by Professor D. J. Demorest:

[1]Condit, D. D., Trans. Am. Foundrymen's Assoc., Vol. 21, p. 26.

	Per cent
Silica, SiO_2	97.47
Alumina, Al_2O_3	0.72
Ferric oxide, Fe_2O_3	.38
Calcium oxide, CaO	.00
Magnesium oxide, MgO	.06
Titanium oxide, TiO_2	.09
Loss on ignition	.60

A microscopic examination by D. D. Condit showed the following minerals which are arranged in the order of their abundance.

1. Quartz. 2. Tourmaline. 3. Zircon. 4. Limonite. 5. Kaolinite. 6. Microcline. 7. Sericite. 8. Hematite. 9. Rutile. 10. Zenotime.

LIMESTONE

The limestones which occur in thin beds in the Pennsylvanian formations are of minor economic value. Only three horizons outcrop in the county—the Lower Mercer, Upper Mercer, and Putnam Hill. The Lower Mercer limestone is not extensive'y developed above drainage and would be available at the outcrop at only a limited number of places. The Upper Mercer limestone generally is quite flinty, and hence of an unsuitable quality. Only the Putnam Hill limestone is at present being utilized.

The Putnam Hill is the most important limestone horizon in the county and has been quarried in a small way at a number of places. It is a hard, dense rock, and because of its color is known locally as the "gray limestone." The thickness varies from 2½ to 8 feet with an average of more than 3 feet. Because of a tendency to break up into beds 4 to 12 inches in thickness, it is often spoken of as a "plate rock," and the partings are better developed where the rock has a shallow covering only. This characteristic makes quarrying much easier.

The Putnam Hill limestone outcrops at numerous places in Franklin, Salt Creek, Paint, and Sugar Creek townships, but is found most extensively west of Fredericksburg in Franklin Township, and in the vicinity of Mt. Eaton.

By far the most extensive use of this limestone is for agricultural purposes. Since all of the soils of the region are acid, one of the first steps in increasing crop production is the application of lime, as has been shown by the work of the Ohio Agricultural Experiment Station at Wooster.

The Putnam Hill limestone has been quarried for many years in the vicinity of Mt. Eaton and has been burned by the farmers for local use. Small piles are made by placing a layer of logs on the ground, and then alternate layers of limestone and coal until the pile has a height

of 6 or 7 feet when it is fired and burns for several days. If well burned the rock breaks down to a powder and can be spread on the land quite readily.

Of recent years ground limestone has come into favor and small pulverizers are being installed for supplying the local demand. One of the most extensive developments is located just north of Munser Knob in Section 22, Franklin Township. A stock company has installed a 100-ton pulverizer, and a good grade of agricultural ground limestone is prepared. Another small crusher has been installed 1 mile east at the base of Sterrett Knob in Section 23. Because of the large number of favorable outcrops, there are very good possibilities in the further development of this industry.

In addition to its use for agricultural purposes this limestone is being crushed to some extent for road building. In 1919 considerable limestone was quarried from the bed of the highway 1¼ miles east of Moorland, and was crushed for this purpose. There are numerous other places where it could be easily quarried and used for road building. A 3-foot bed will yield about 11,000 tons per acre or enough to build about 3.7 miles of standard macadam road. Undoubtedly there is sufficient limestone in Paint and Franklin townships, which could be easily quarried, to build many miles of good road.

The value of the Putnam Hill limestone for agricultural purposes is shown by the following analysis by Mr. George Valley of a sample from Section 22, Franklin Township, where the rock is being ground. The results are expressed in the form required by the Ohio limestone law.

Composition of Putnam Hill limestone

	Per cent
Total neutralizing power in terms of calcium carbonate	95.97
Calcium	36.32
Magnesium	1.18
When recalculated to the carbonate the result is as follows:	
Calcium carbonate	91.11
Magnesium carbonate	4.09

This analysis shows a rather high total carbonate content and a low percentage of magnesium.

BUILDING STONE

The sandstones of the upper part of the Waverly and of the Pennsylvanian formations have been quarried to a limited extent for building purposes, especially for foundations, but at present comparatively little local stone is used in the county.

PLATE X.

A.—View of the Putnam Hill limestone showing the tendency to break up into thin plates.

B.—Limestone crusher north of Munser Knob preparing agricultural limestone.

The fine-grained sandstones of the Logan formation have been quarried at a number of places near Wooster. Reddig's quarry, just north of that city, was probably the largest. No stone has been removed for many years, but the large pits are evidence that quarrying has been carried on extensively in the past. The bedding and jointing of much of the Logan formation is irregular and in many places the beds are thin. For the most part it is of little value as a building stone, except possibly for foundations.

Coarse-grained sandstones have been quarried at a number of places in the eastern and southern parts of the county, and the gray rock on Chestnut Ridge northwest of Rittman was used in the construction of the courthouse at Wooster. Several other quarries have been operated to a limited extent at various times, but at present no stone is being removed.

ROAD MATERIAL

The scarcity of good road material in Wayne County is attested by the small percentage of improved road as compared with many of the counties in western Ohio where there is an abundance of limestone. In a few places limestone from the Pennsylvanian or Coal Measures has been crushed and hauled on the roads.

Gravel is found in moderate quantities in certain parts of the county and has been hauled onto some of the roads. Between Shreve and Big Prairie a fair quality has been secured. A large pit has been opened southwest of Wooster in the northwest corner of Section 16, Wooster Township, and 2½ miles north of Orrville, in Section 7, Baughman Township, there is another large one. Between Creston and Burbank in the northern part of the county there are a number of moderate sized gravel pits.

For the most part the gravel in Wayne County is of only fair quality for road material, since it is made up quite largely of sandstone and shale. Occasionally the finer material is somewhat calcareous and this of course increases the bonding power. However, there is no doubt that the roads are much improved where gravelled with this material.

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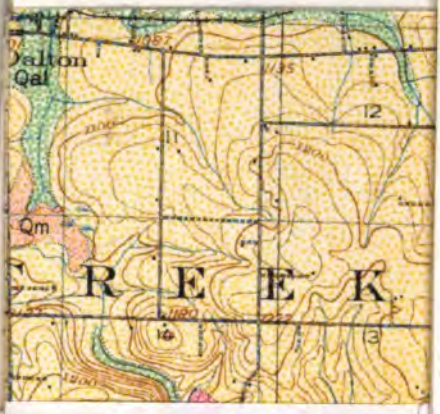
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